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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 103 NEW YORK, NOVEMBER 28, 1929 Number 22

Facts Give the Answer

FACTS on the outlook for construction in the immediate future and in 1930, compiled and summarized in this issue, disprove any expectation of depressed business conditions. They show, on the contrary, that a year of busy activity lies ahead. The stock-market collapse will prove a stimulator rather than a retardant. The showing is such as to be completely reassuring to all who may have felt doubtful about the continuance of construction work.

The report speaks for itself. But its unusual significance in connection with the effort of President Hoover to rally the powers of business courage against the possibility of a panic invites further reflection. Construction is closely interwoven with general industrial activity, as well as with those economic facts which influence every man's personal welfare.

CONFIDENCE is re-establishing itself. Within the past few days men have been coming to realize that business was little deranged by the experiences of the stock speculators. Our industries and our commercial machine are intact and operative.

Carrying out the President's appeal to check all tendency to loss of confidence, railway heads and industrial leaders sat down with Mr. Hoover late last week and reported continuing construction activity in their fields. This was of tremendous value. In so far as they promised some expansion of their construction programs, they made a gesture of good will tending to reinspire others with courage, but accomplished no more. They could not safely assure that they would increase their construction work, for in the present age maintenance and construction must be adjusted closely to current rather than to expected future needs. The solid contribution that the industrial captains brought to the President's council was their report of facts.

And facts were so obviously the need in the construction industry that even before the Washington meetings *Engineering News-Record* sought them out by widespread telegraphic inquiry throughout the field. It asked its friends to tell of their present situation, the conditions which govern their prospects and their definite program so far as one has been laid down. Because they replied fully and without hesitation we are able at this early date to report the facts and thereby sketch an illuminating picture of what lies ahead.

CONSTRUCTION will continue undiminished in a large number of departments, may decrease in a few, but is likely to increase in others. The general level of the past two years will easily be maintained, and this without the extra impetus now sought to be given to it by the President and the state governors. In other words, there is as large a need for construction as a year ago or two years ago, and the country is able to supply it without departing from its normal course.

These conclusions are conservative, for the facts on which they rest were not influenced by the present endeavor to increase the volume of construction. It will be recognized that the reports from our correspondents are tangible and soundly informing, and are free from window-dressing.

Specifically, public works will go on without decrease and with some probable increase. The great private works of railways, utilities and industrial concerns will be on the same scale as heretofore, proportionate to the immediate requirements of production—for as above suggested it has been learned that building too far ahead is uncertain and wasteful. Private building, which has been checked during eight or nine months past by dear money will be revived by the normalizing of the money markets. Easier money will benefit all construction.

IN THESE days nearly ten billion dollars is expended on construction each year. The 1930 season will total fully up to that figure. This is the nation's ultimately essential investment, that to which all other expenditures are auxiliary—expenditures for garments to clothe and meat to feed the family of the workman who makes the beams and bricks and bolts that compose our permanent works. If ten billions go into construction next year, other industry will also hold up. It is clear that construction is a decisive stabilizing force in so fully developed a production system as ours.

In order that there may be no hitch in this chain, wages and credits must be kept sound. The maintenance of wage levels has had attention at Washington. Henry Ford with characteristic timeliness focused strong light on the subject by announcing a wage increase for his hundred thousand workers. His basic idea is probably right: if anything will tend toward unbalance of the country's economic adjustment it is a diminishing margin of the worker's consuming power. An industry that can afford to increase the worker's share will strengthen itself by so doing. Wage reductions are not in tune with the pace of the present.

CREDIT is the other point of critical adjustment. With everything else in good order, the country's existence can be badly disturbed by poor credit conditions; and even though credit is in substance a measure of our productive margin, yet it is administered by human hands and is subject to human weakness.

In view of the importance of this factor, the indications obtained from our inquiries into construction finance to the effect that bankers and money lenders venture the

least definite, the most hesitant statements on present and prospective construction is important. They have money available for bond investment, but they hesitate to speak of the soundness and price of the bond market; they have money for mortgage loans, but they are doubtful about their readiness to make such loans.

It is hard to avoid the reflection that our banking and credit system is decades behind our industrial and commercial system in development, and that bankers live in bygone years. Nevertheless the outlook even in the credit field is excellent, for credit is in final analysis controlled by the spirit of the community. And that, as said at the start, is rapidly getting back to good balance and sane optimism.

FINALLY, in restating the highly gratifying nature of the facts brought out in this survey, we wish to express deep acknowledgment to the public officials, the engineers and contractors, the architects and industrial chiefs, who responded so fully and clearly to our call for data. They have contributed to a total of information that is of effective value at this unusual time.

Recognizing Exceptional Achievement

A FITTING award was made by the American Institute of Steel Construction in distinguishing the Sixth St. suspension bridge at Pittsburgh for esthetic merit among bridges built in 1928. The excellence of the result achieved in this structure and in its two neighboring counterparts, the Seventh and Ninth St. bridges, has already been acknowledged in these columns and in the comments of virtually every engineer who has seen the group. An established award gives the emphasis of public recognition to those evanescent factors of excellence in design which engineers constantly strive to incorporate in their work, but only too often are forced to disregard. By encouraging this striving through its award for esthetic merit, the organization strengthens the influence of imaginative idealism in engineering work.

Blasting for Power Shovels

FACTS of importance in the economical operation of power shovels are emphasized in the study in this issue of shovel performance as influenced by the material excavated. Incidentally the shovel records from which conclusions are drawn are probably the most extensive that have ever been accurately and purposefully determined. The conclusions that stand out are that poor mechanical conditions increase the length of the operating cycle some 14 per cent and the time lost from major delays about 25 per cent; that ordinarily in actual practice from 35 to 40 per cent of the working time is lost in short delays not exceeding fifteen minutes; and that well-blasted rock can be handled about as rapidly as ordinary earth. Contractors commonly fall into the error of "saving powder" in rock excavation by power shovel. The error is most usual with the contractor for general excavation who only occasionally runs into a rock cut in the course of his earth-handling operations. He approaches the task with the conviction that reduced shovel output is unescapable and endeavors to cut costs by doing the least possible amount of blasting. In disclosing the error of this practice the studies of the Bureau of Public Roads engineers, as given on another page, perform a needed service.

Erosion and Runoff

INTEREST in methods of checking soil erosion and slowing up runoff has been unusually active since the 1927 flood in the Mississippi Valley. The two go hand in hand in the matter of aggravating flood conditions. Rapid runoff causes rapid erosion of the soil which might be used to hold back the rainwater. Also, silt, the product of erosion, fills up stream channels and spreads the damage caused by high runoffs. For these reasons, civil engineers are finding it desirable to inform themselves upon methods of checking soil erosion. In this issue C. E. Ramser, of the Department of Agriculture, describes the methods of checking erosion which are being tried out by the department under a special authorization granted by Congress last year. The department's interest, of course, is centered in safeguarding the agricultural value of the land. Nevertheless, its studies eventually will result in the development of much of interest to other fields. Civil engineers will hope to obtain from them better means of determining how much the runoff of cleared areas may be affected by contour plowing and terracing, how much the silt content of streams may be reduced, how far the increased percolation of rainfall into the soil as a result of terracing will influence the low flow of streams, and how much the total runoff will be affected by increased evaporation losses. These are factors of direct importance to all who have to do with the flow of our rivers, for water supply, power development or flood control.

Breaking Faith

THE foundation of our present system of competitive bidding is based on the principle that the contractor submitting the lowest bid is entitled to receive the contract, provided, of course, that he is a legitimate bidder and has complied with bidding requirements. This principle was recently ignored in New Haven, where the city administration seemed determined to award a half-million dollar sewage plant to a local firm regardless of bids submitted by outsiders. If such was the intention, it should have been so stated in the official call for bids so as to save outsiders the expense and trouble of bidding. The details of the New Haven contract award are given in our news pages this week. Rejecting all bids on the first proposal when it was found that an outside firm was low, the administration called for bids a second time on a basis of three alternatives (two makes of equipment and a combination of the two). The contract was awarded to a local firm which was low on the combination bid, though fourth from low in considering all alternatives. We cannot see the justice in ignoring the bids on one make of equipment, when that particular make was apparently given an equal standing in the official specifications—as it must be in sound public-works contracting. The New Haven mayor's statement that the taxpayers have been saved $20,000 is far-fetched, as the contract awarded totals over $3,000 more than the low bid submitted in the first proposal. New Haven did not keep faith with the contractors. Such practice is to be condemned if the best interests of owner and contractor are to be maintained.

A Critical Association Problem

THE annual meeting of the Association of State Highway Officials holds a distinctive place among conventions of public-roads technicians. Its delegates are the engineers and administrators of a state and federal road system of 310,000 miles carrying some 80 per cent of the highway traffic of the United States. At the time of its conception, administration and engineering were given equal place in the purposes of the organization. In theory there has been no change in its purpose during fifteen years, but its deliberations have swung more and more to the side of engineering, until problems of administration command comparatively minor attention. The organization has become preponderantly an engineering association. This situation warrants thought.

In this relative sublimation of engineering, is the association fulfilling its main purposes? Obviously by such action it is not carrying out the thought which guided its formation, but the situation may have changed and may now call for re-orientation of plan. Let us then ask whether its greater duty today is toward highway administration problems or toward problems of design and construction. This question seems to call for a considered answer at this time, when highway traffic is crying insistently for more roads and better roads and when the financing of these roads is complicated by a high road-user tax and by the growth of a strong public sentiment in the direction of reducing general taxation on property.

Highway engineering concededly needs continued study. It is far from meeting all the demands of road design and construction, particularly in view of the rapid evolution of highway service. Engineering development ought not to be retarded to give time and place for studies of financing and management, but rather should be accelerated to provide the basis for successful administration. However, by the same token administrative problems must be given prominent place in the official thinking of highway officials and in the co-ordinating work of their association. Nominally they have this place in the association's committee organization and group subdivision, but actually they arouse little interest among the membership or in the sessions of the convention. This fact was never better illustrated than at the convention two weeks ago at San Antonio, where the emphatic reference to financing problems by speakers of official prominence brought scarcely a whisper of discussion—or even the hush of an interested audience. Potential interest was not lacking in this group, but no one waked it to life.

Patently the attitude of the association mind is not properly adjusted to the real demands of the work in hand. The association operates as though its prime task were to study engineering problems, and as though such subjects as highway finance are outside of its immediate field, except for regular insistence on continued federal aid appropriations. Such a course of action suggests a serious misjudgment of the present-day situation. Granting that questions of finance, of taxation and traffic servicing do not overshadow those of engineering planning and design, yet they are of co-ordinate importance, and cannot be ignored without imperiling the association's standing and influence. Unless the organization devotes serious attention to their solution, it will risk its highway leadership, and in addition will jeopardize highway progress by inviting ill-advised and perhaps destructive legislation. There have been too many examples of such legislation in the past year to warrant any attitude of complacency by public-roads officials or by the association which reflects their concerted thought and action.

International Contacts

GREAT gatherings of engineers from all parts of the world, such as assembled at Tokyo this month, represent a force for the advancement of human effort that does not often find adequate recognition. It works powerfully for the kinship of men because it brings together those who constitute the real agencies of modern progress, the doers and builders. These men, by talking together of problems that are the same in the East and in the West, are enabled to sweep away the superficial differences of climate, dress and tongue. An observer's report of the Tokyo Engineering Congress printed in this issue brings out the predominating value of the social contacts developed at that assembly. The emphasis is appropriate, we think. Much more ought to be done in the establishment and maintenance of international contacts, were it not so formidable an undertaking.

What the engineers and public men of Japan have done to make the Congress a successful gathering claims grateful acknowledgment. It provided a means by which the Orient with its tremendously rapid growth could impress itself more fully upon the consciousness of other regions and attain better recognition as an active participant in the world's work. Thereby the future co-ordination of useful work on the opposite faces of the globe is made easier, and its ultimate achievement brought nearer. Countries that use calipers of the same kind, build under similar building codes, and store water or develop power in the same way, cannot long be strangers.

Present habits, unfortunately, make such interchange of visits contingent upon ponderous and unproductive meetings at which dreary papers of encyclopedic content are read. Vast wastes of labor are involved in the preparation of this performance, and in corresponding degree the result is technical disappointment. Though this has been so on many an occasion, international congresses continue to be organized under the same procedure. A change in the system would be constructive.

Detailed development of this point is not feasible at present, for up to now not even the program of the technical meetings has been made public, much less a record of the papers. But, as might be guessed, the report indicates little discussion. It is clear even now that none of the virtue of the Congress lay in its papers. The personal contacts constituted its value.

Would it not be better if the futility of holding an engineering congress were frankly acknowledged, and if the industrial survey visits always attached to such congresses were elevated to prime position? In these visits is developed the essentially helpful and constructive contact between hosts and visitors in the field of their productive thinking. Full recognition of this fact would doubtless bring about an organization of the meetings which would yield a maximum of return for the effort applied.

Such thoughts, however, if they have value, must find their application at a future time and bear only in retrospect on the Tokyo gathering. The decisive success achieved there, essentially because of the strong purpose and thorough planning of the nation which acted as host, sets a milestone in international understanding.

Large 1930 Construction Volume Forecast

Results of a Telegraphic Survey—

Reports From All Sections Indicate No Bad Effects of Stock-Market Collapse—Current Year May Be Exceeded—Public Works Reach Large Totals—Utilities and Industries Contemplate No Curtailment—Financing of Construction Will Improve

WHAT are the construction prospects for 1930, as affected by the recent collapse of the stock-market boom?

Are there any indications of a tendency to curtail expenditures?

How will the reaction on the market for bonds influence construction programs or ability to finance new work?

Based on these questions, *Engineering News-Record* last week made a telegraphic canvass of public officials, engineers, architects, financial houses and others. Replies from all sections of the country and all branches of the field give a favorable answer. They show no indication of curtailment and forecast a construction volume in 1930 that will easily equal the records established in the current and preceding years, and may go beyond them.

The Main Results

Activity in public works will be undiminished. The highway work of the various states, based on virtually complete returns, figures to exceed that of 1929 by some 10 per cent. Municipal construction, varying with particular local needs, in general trends toward a figure above the average of recent years. Both these fields are affected little or not at all by the bond market, and are not likely to be changed materially by changes in the business situation.

Corporations and utilities plan to maintain their development budgets in full. The railroads, with some eight hundred millions of new-capital work planned, may even increase the total to a full billion in response to President Hoover's urging for increased construction to counteract any tendency toward a depression. The construction budget of the other utilities is almost as large.

In the field of building, which eight or nine months ago slowed up sharply (chiefly or solely in small residential work) because of tightening loan funds and local overbuilding, recovery is beginning, but its progress may be rather gradual.

Financing will be freer than for a year past. The bond market has already improved, and bond houses expect it to advance steadily to a normal position. Some municipal or state work had been held up during the last year by inability to sell bonds at attractive prices by failure of bond-issue referendums, and in a few cases by unwillingness of the public authorities to issue bonds even after authorization. No further check to work from these causes is to be expected. Mortgage money may remain tight for some time.

Engineers and architects are busy. Few have had work cancelled or postponed because of the stock-market collapse, while others, on the contrary, have had previously deferred work turned into definite projects because of this event. Expected work for 1930 is of normal volume, except for anticipated reduction in private work of moderate size, chiefly in the Middle West and South. Contractors are in a strong position. The same is true of equipment and material men, who report lower inventories than a year ago and look for an active season. Group summaries of the reports follow.

The Outlook in Brief:

- **Highway construction will equal and may exceed 1929.**
- **Municipal programs are being fully maintained.**
- **Utilities are planning normal growth and expansion operations.**
- **Large industries contemplate no curtailment of construction.**
- **Railroads may increase new-capital work from 800 million to a billion at President Hoover's suggestion.**
- **Equipment and materials have big year, but expect further improvement.**
- **Engineers, architects and contractors find business maintained or picking up.**
- **Bond prices are rising; normal rates to prevail soon.**
- **Mortgage lenders inclined to continue cautious for some time.**

Consulting Engineers and Architects Make Encouraging Reports

"The market collapse is the best thing that could have happened to the construction industry by releasing cheap money," says a prominent Chicago consulting engineer. Consulting engineers and architects unite in believing that the stock-market crash will result in a better bond-market situation that will greatly stimulate public construction projects, and that industrial building will proceed favorably under easier money conditions. New work has been retarded for some time by a poor bond market, but work under way and on hand has suffered little.

A Milwaukee engineer says: "In all my 40 years of experience, this past year is the only time that I can recall that bonds have not been offered for sale as soon as authorized. Many public officials have withheld authorized bond issues from the market rather than sell below par. Now public and private work will both go ahead."

Extracts from other reports from various parts of the country reflect the prevailing opinion of prominent consulting engineers and architects:

Little Rock: "Construction prospects better than average due to cotton crop and improved bond market."

Chicago: (1) "Numerous building projects available as soon as commercial houses are in a position to make loans. Plenty of prospects, but loans difficult to get until financial houses read-

just themselves." (2) "Construction not to be curtailed except where owners are holding off waiting for lower materials and labor. Stagnation in bond market last year and overbuilding reduced current office building and apartment construction."

Portland, Ore.: "Some public work has been postponed waiting more favorable bond market. Government work proposed is encouraging."

Seattle: "No diminution in public or private work."

New Orleans: "Public construction above average and will continue. Private work slow and some definitely postponed."

Harrisburg: "Public and private work below average and will continue such, at least for several months."

Boston: "Busy. Not much in sight, but usual for this time of year."

Detroit: "Present trend shows less than average business. Public work will be maintained, but private work curtailed."

Chicago: "More prospects have turned into definite signed projects in last three weeks than in the previous eighteen months."

Gainesville, Fla.: "Florida optimistic. Big money scarce, holding back improvements. Former expansion holding back some municipal improvements."

Minneapolis: "High money rate past year has hurt. Construction will benefit by improved bond market."

Jackson, Mich.: "Projects totaling many millions not impaired. Improvement in bond market encouraging."

Pittsburgh: "Both public and private projects for next year above average."

New York: (1) "No slackening noticed. More recent inquiries. Lower market will improve projected construction." (2) "Work below normal. Prospects below normal, but much better than two months ago." (3) "Work on hand above normal. Prospects normal. When market settles down, easier money will help construction." (4) "Prospects above average. Heavy construction will increase. Apartments, office buildings and residences will decrease." (5) "Work below normal. Some postponements, but believed of short duration. Normal outlook for coming year." (6) "Work below normal. Some work being cancelled because of market, and prospects below normal."

San Francisco: "Building slowed up past few months because of stock-market activities. Expect building work to reach large proportions by middle of next year."

Kansas City: (1) "Public work retarded past few months because of poor bond market. Private construction active." (2) "Prospective business compares favorably with past few years. Private and public construction will be normal."

Many of the firms quoted here are doing a nation-wide business, so that their opinions reflect more than a local viewpoint.

Highway Work Likely to Exceed 1929 Figure

The estimated total expenditure for state road work in 1930, reported by 42 states, is $668,000,000, which is $76,000,000 more than the expenditure of the same states in 1929. Only three states anticipate a definitely smaller expenditure, and only thirteen states report that there will be no increase. One-half of the states report specifically that the condition of the bond market will not affect their highway financing; no state indicates that it will be a factor. This means that the approximate total of two billion dollars annual road and street construction by all public authorities will easily be maintained. The bond market will have no influence on state road funds.

These conclusions are based on personal interviews with leading highway officials of a score of states and on telegraphic statements from the highway departments of 42 states. There is no danger of sectional slump in highway activities. At most two or three individual states report a doubtful situation because of factional politics. In all these special cases the condition is an old one and of no special significance in the present juncture.

Road-Building Continues at Full Speed

Road work in 1930 as reported by 42 states will amount to $668,000,000, which is $76,000,000 more than in 1929.

This means that the approximate total of two billion dollars annual road and street construction by all public authorities will easily be maintained.

Minnesota's 1930 construction program (state work), $11,000,000. Paving is 230 miles, a 100 per cent increase over current and average year; grading 240 miles, and graveling 300 miles—these and structures about average. County construction, $12,000,000, $2,500,000 increase over average owing to diversion of gas tax to counties.—C. M. Babcock, Commissioner.

Oklahoma's anticipated expenditures for 1930 are: Paving, 350 miles, $7,500,000; bridges, $2,000,000; grading and drainage, 420 miles, $2,500,000. Total construction, $12,000,000; total maintenance, $3,000,000. County bonds influenced only slightly by bond market.—A. R. Losh, State Highway Engineer.

Wisconsin will directly supervise $15,500,000 for highway construction in 1930; $14,500,000 spent in 1929, which was average year. Construction not influenced by bond market, except for higher interest paid on some county bonds. Under the existing legislation in this state, only a slight normal increase in construction funds can be anticipated. —Jerry Donahue, Chairman State Highway Commission.

California's state highway construction and maintenance is continuing on programmed basis of about $30,000,000 yearly, with program definitely arranged for two years ahead to take full advantage of construction seasons. In addition, the various counties will receive next year about $16,000,000 from motor vehicle fees and gasoline taxes, this amount increasing uniformly each year. Improved conditions of bond market should cause an increase in municipal and district improvements. *Indications are that next year public work in California will at least equal the total for this year.* With ample supply of labor and contractors keenly competing, favorable bond market creates satisfactory situation for economically carrying forward public work. —C. H. Purcell, Chief Engineer, California Division of Highways.

Pennsylvania will expend during the fiscal year ending Jan. 1, 1930, approximately $61,000,000. Expenditures have for the last ten years averaged $41,000,000 a year. Expenditures for the present and next year will not be affected by the bond market.—James L. Stuart, Secretary of Highways.

New York Department of Public Works awards contracts for highway construction, canal improvements and state building construction. The budget requests and other funds available exclusive of maintenance charges and personal service for the coming fiscal year are approximately as follows: highways, $62,000,000; parkways, $3,000,000; railroad grade crossings, $30,000,000; canal contracts (construction and equipment), $775,000; public buildings, $50,000,000; total, $145,775,000. This department is in position to carry on a larger program than the above budget requests allow. In regard to the grade-crossing eliminations, you have doubtless seen the suggestion of Governor Roosevelt, by which a vast amount of red tape can be eliminated from our present method of procedure. Should the legislature co-operate with the Governor in this matter, the department in all probability would be able to speed up grade-crossing eliminations to such an extent that a much larger sum could be expended. The requests of this department for the coming fiscal year represent an increase in our construction program of 85 per cent as compared with the average yearly program for the last five years. —Frederick Stuart Greene, Superintendent of Public Works.

Ohio's construction program for 1930 will amount to $23,000,000 or $24,000,000, including federal aid of approximately $2,750,000, and small amount of county and village co-operation. This will be in excess of 1929 program by about 50 per cent, and will include some 1929 money not placed under contract. Program will be larger than average year. Program not influenced by bond market, except in possibly a few localities where county participation is expected; no trouble anticipated.—Robert S. Beightler, Chief Engineer of Construction, for Robert N. Waid, Director of Highways.

Louisiana's next year's program will be about $22,000,000. Not influenced by bond market. This is about double both current and average year. About 75 per cent of the expenditure will be for concrete pavement.—Harry B. Henderlite, State Highway Engineer.

Wayne County's budget for new construction includes widening existing roads, highway bridges, grade separations, wider widths of right-of-way, approximately $9,000,000. An additional $3,000,000 will be spent in this county for above purposes from money received through railroad participation in grade separations, federal aid and state highway department participation; $1,750,000 will be spent on covert or assessment district

roads. Every likelihood additionnal sums will be raised during 1930 for additional mileage ot assessment district roads. Of above amount $2,715,000 is budgeted for wider right-of-way. An additional $550,000 is budgeted for right-of-way for county parks, and $200,000 for maintenance of present parks. This sum approximates $13,500,000, the largest sum ever spent in Wayne County for one year.—EDWARD N. HINES, Chairman County Highway Commission.

Figures for 1929 highway construction were somewhat less than 1928 and 1927, which was the peak in expenditures for state and local highways. Figures sent from 28 states during the past week indicate a slight reduction in 1930 construction program. [This is contradicted by our replies from 42 states.—Editor.] Only four of these states are planning any large increase in expenditures over 1929. These states have indicated that present market will not affect 1930 program, but we believe the availability of cheap money and reduced construction cost will influence states to increase construction program before beginning 1930, and also such influences as the present prosperity program. This association is carrying on an educational campaign for the purpose of urging states, counties and cities to take advantage of the situation and plan large road programs for 1930.—CHARLES UPHAM, General Manager, American Road Builders Association.

Replies from many engineers and architects give an encouraging picture of next year's work. As to present signs, a leading Chicago architect says: "More prospects have turned into definite signed projects in the last three weeks than in the previous eighteen months."

Municipal Work Variable; May Run Ahead of 1929

City construction expenditures as revealed by canvass of the larger cities indicate that the heavy programs of recent years will continue, in response to growing municipal needs. There will be decreases in a few cities due to completion of large work this year or last, but many other cities have increased work projected. In many localities the program has yet to be approved by council or other authorization, and a few bond-issue referendums are still to be held. The total of the uncertain items is not large enough to modify the general picture.

Bond prices and interest rates are reported by many cities to have no influence on municipal construction programs. A few report that work has been reduced in the recent past by difficulty in selling bonds advantageously; this difficulty is likely to be decreased by improvement of the bond market through release of stock-market funds.

Extracts from replies of city authorities follow:

Program for 1930 not made up, but anticipate no material change. Bond prices will probably not affect us.—R. G. LINGLEY, City Engineer, Worcester.

Construction projects total about $25,000,000, of which largest are sewage-disposal plant, $10,000,000 and city hall, $7,000,000. This year's total for paving, bridges, buildings, sewers and water mains was about $10,000,000. Bond prices had no adverse influence on our construction work this year.—GEORGE T. FISKE, Commissioner Public Works, Buffalo.

Estimated water-main construction for 1930 totals over $5,000,000, pumping stations $1,050,000, wells and pumps $500,000. Bond prices have virtually no influence on our next year's program, as water bonds are exempt from debt limit.—W. W. BRUSH, Chief Engineer, Department of Water, New York City.

We have a $6,000,000 construction program for next year. This is part of a five-year program on which the present financial situation has no bearing.—JAMES W. COSTELLO, Chief Engineer, Department Public Affairs, Newark, N. J.

Program for 1930 between $6,000,000 and $15,000,000, dependent on financing by bond issues. Authorized projects now financed $5,000,000. Contracts awarded in 1929 about $8,000,000. —EDWARD G. LANG, Director Public Works, Pittsburgh.

Proposed 1930 outlay of $2,540,000 is about normal; add $150,000 for municipal pier and $1,500,000 for James River bridge, both unusual improvements. Unless bond market improves may finance by temporary loan.—R. KEITH COMPTON, Director Public Works, Richmond, Va.

Immediate construction program includes $100,000 for new sanitary sewers and $100,000 for underpass. Budget expenditures normal. High bond interest rates tend to delay proposed paving. —WAYT THOMAS, Acting City Engineer, Charlotte, N. C.

Vote on $3,000,000 bonds for hospitals in February. Other projected work exceeds $1,000,000. Projected work always exceeds work for previous year. If bond prices are low, hard to get favorable vote for bonds.—WILLIAM A. HANSELL, Chief of Construction, Atlanta.

Next year's work will be about average of last ten years.—W. E. SHEDDON, City Engineer, Jacksonville.

Estimates for 1930 total $2,500,000, or about 70 per cent current year and 60 per cent of average for recent years.—A. J. HAWKINS, City Engineer, Birmingham.

Probably total expenditures will be about the same as for current year. The 1929 expenditures totaled $2,110,000, against an average of $1,479,000 for the ten years ended with 1929. In addition two projects now being carried out require $4,000,000 expenditure in 1930, and $1,100,000 will probably be spent on schools and water. Our bond sales have been satisfactory.—A. A. KRIEGER, Chief Engineer, Department of Engineering, Louisville.

Program for 1930 as good as or better than average year. Five municipal bodies contemplate spending $20,250,000 on schools, paving, lake front development and other levee work, docks, water, sewerage and drainage extensions.—BRYSON VALLAS, City Engineer, New Orleans.

Expect to spend about $3,000,000 for new pavement, which is 10 to 15 per cent in excess of last four-year average; also about $1,000,000 for street maintenance and minor reconstruction. Other items exceed $3,000,000.—H. P. SHIPLEY, Engineer of Highways, Cincinnati.

Next year's municipal construction may amount $7,000,000 or $8,000,000, which probably will be less than for 1929. Any falling off partly due to failure of bond issue votes Nov. 5.—ROBERT HOFFMANN, Chief Engineer, Cleveland.

Construction projects now in sight for 1930 total about $3,300,000. This is 50 per cent more than for 1929 and 25 per cent above average for past five years. Bond prices are not expected to affect 1930 program.—W. H. DUFFY, Director Public Service, Columbus.

Expect to spend $2,000,000 for sewers, $1,000,000 for track elevation, $500,000 for flood protection and bridges, which is about our average. Bond prices have only slight influence.—A. H. MOORE, City Engineer, Indianapolis.

Total expenditures $20,200,000 in 1929 and $20,300,000 in 1930. Bond prices will not affect volume or prices.—P. A. FELLOWS, City Engineer, Detroit.

Estimated cost of work to be done in 1930 by board of local improvements greatly exceeds 1929 and average year, as follows:

	Estimated, 1930	1929	Average Year
Pavements	$15,000,000	$15,000,000	$15,000,000
Sidewalks	1,700,000	1,700,000	1,712,000
Sewers	11,500,000	2,050,000	2,250,000
Special projects	6,100,000	2,500,000	1,500,000
Total	$34,300,000	$21,250,000	$20,522,000

M. J. FAHERTY,
President, Board of Local Improvements, Chicago.

Projected 1930 construction totals $6,000,000, same as average for last five years. About $4,000,000 bond issues. Bond prices affect annual bond issues by their reaction on sinking fund requirements in determining net bonded debt of city.—NATHAN HARRIS, Engineer, Minneapolis.

Considerable more city and private work will be done here in 1930 than in any single recent year, mainly due to new court house and city hall, addition to auditorium, and increased street work.—J. W. KELSEY, City Engineer, St. Paul.

Closely approximate costs of work in charge of department public improvements $1,000,000 for 1930 against $800,000 in 1929 and $1,675,000 for last ten years. Work not as yet affected by bond market.—HERMAN BEAL, City Engineer, Omaha.

Construction for 1930 will maintain average. Includes increase of 30 per cent in paving and drainage, offsetting work completed. —W. E. ROLFE, Board of Public Service, St. Louis.

Our 1930 construction work will total about $2,600,000, or 25 per cent above 1929, which was an average year. Increase due to union station work. Bond prices have added about 10 per cent to paving prices.—K. R. TEIS, City Engineer, Tulsa.

Comparative costs all kinds city construction for 1930 are

$5,200,000, against $2,900,000 in 1929.—JOHN M. YOUNG, City Engineer, Dallas.

Due to recently completed work, construction for 1930 will be much under 1929.—L. EWIG, City Engineer, San Antonio.

Program for 1930 incomplete, but will total about $4,000,000, which is somewhat below average year. City bond prices good.—A. C. VICKERY, City Engineer, Denver.

Public improvements for 1930 estimated at $350,000, same as 1929, but below five-year average of $480,000. All paid from current revenue; no bond issue since 1919.—HARRY C. JESSEN, City Engineer, Salt Lake City.

Cost of public works in 1930 will be about $16,000,000, against $20,000,000 average for past five years. In general, bond prices do not affect volume of our work, as 90 per cent is financed by local assessment districts.—JOHN C. SHAW, City Engineer, Los Angeles.

Program for 1930 totals $26,525,000, against $18,510,000 for 1929, but $20,000,000 of the 1930 program depends on sale of 4½ per cent bonds not readily marketable under present market conditions but have been assured of sale at present of some $5,000,000. Comparative figures for 1930 and 1929 follow: streets and boulevards, $7,400,000 in 1930, against $10,500,000; aqueduct, $8,000,000 and $5,600,000; buildings, $8,000,000 and $2,000,000; incinerator, $1,000,000 in 1930; sewers, $925,000 and $510,000; reclamation, $800,000 in 1930; airport, $200,000 and $160,000; traffic control, $100,000 each year; playgrounds, $100,000 and $40,000.—M. M. O'SHAUGHNESSY, City Engineer, San Francisco.

> **"We are convinced that there is sufficient momentum behind at least our part of the construction industry to carry it well beyond any hypothetical danger point."**
>
> ***—A leading New York contractor, doing a nation-wide business.***

My judgment is that city construction will be about 10 per cent less in 1930 than average. Streets, sewers, viaducts and water mains will cost about $4,000,000, against $4,500,000 in 1929. These figures do not include waterfront project costing $2,775,000 or Bull Run dam costing $2,500,000 spread over several years but completed this year.—O. LAURGAARD, City Engineer, Portland, Ore.

Our budget for 1930 is same as for current year and will be considerably increased when present river and harbor bill passes, permitting work to start on 35-ft. Columbia River channel. There is every indication of an active public and private construction program in this vicinity for 1930.—JAMES H. POLHEMUS, Chief Engineer, Port of Portland, Ore.

Construction prospects for next year in this territory appear fairly bright. Port of Seattle will probably spend on new construction about $500,000. Seattle municipal work practically same as current year.—J. R. WEST, Chief Engineer, Port of Seattle.

Railroad, Utility and Industrial Programs Fully Up to 1929

Electric Utilities—Expectation that expenditures by electric utility companies will continue at least on a uniform plane during 1930 is borne out by replies from sixteen of the major companies picked at random over the whole country. With two exceptions all report expenditures in 1930 the same as or greater than in 1929. The Puget Sound Power & Light Company reports that its expenditure will be less next year due to the fact that a 50,000-hp. steam plant was brought into service this year. The New England Power Association also reports lower expenditures, but as a normal development, not as a curtailment. On the other hand, large increases in expenditures are reported by such widely separated organizations as the Buffalo, Niagara & Eastern Power Corporation and the Southern California Edison Company. The United Gas Improvement Company gives $41,000,000 as the total expenditures on the various properties of that company, an increase of $6,500,000. The Middle West Utilities System reports 75 to 80 million dollars for 1930, as compared with 63 million for 1929.

Slight increases are reported by the Public Service Corporation of New Jersey and the Pacific Gas & Electric Company. Budget figures for the Allied Power & Light Corporation are not yet available, but the utilities of that group expect to spend at least as much in 1930 as in 1929, between 70 and 80 million dollars. These are normal expenditures to meet requirements, not to meet the President's call. American Gas & Electric Company, representing another section of the country, reports 1930 figures equal to 1929 with a possible large addition if pending development plans receive federal approval.

Railroads—Advance estimates of 1930 expenditures by the railroad companies of the country, made by the Bureau of Railway Economics, placed them at $800,000,000. That was before the President's conference with the heads of the larger railroad systems of the country following which it was announced that the railroads would spend $1,000,000,000 on new equipment and facilities and new construction.

In the Southwest, where new construction has been most active, F. E. Williamson, president of the Chicago, Burlington & Quincy Railroad, reports that his road now has an application pending before the Interstate Commerce Commission for permission to build 110 miles in north Texas at a cost of $4,500,000. With this work approved, expenditures for 1930 will exceed any in the past few years. W. B. Storey, president of the Santa Fe System, reports that the 155 miles of new track which his company now has under construction in Texas will be carried to completion in 1930. This railroad also has applications for new construction pending before the I.C.C. for new lines in Texas, Colorado and New Mexico that will have a total length of 380 miles. The part to be spent in 1930 added to that already authorized should amount to $8,000,000, as compared with $4,500,000 in 1929. The Rock Island reports that its budget for 1930 is $10,000,000 greater than in 1929.

Industries—No curtailment of construction operations by such large industrial organizations as the General Electric Company, the Baldwin Locomotive Company or the Aluminum Company of America are contemplated. Practically all of the concerns asked to give a statement as to their future plans reply that they expect their 1930 business to equal that of 1929 and a few expect to exceed it.

Contractors Have Felt No Effect of Stock-Market Drop

Prospects of a better bond market and lower money rates promise stimulation of all construction work, especially public projects, is the belief of leading contractors of the nation. Many of them believe that speculative building will virtually cease for some time to come, but that industrial building, slowed down this past year by high money rates, will make up for it in increased activity. No work has actually been affected by the recent stock-market drop, according to the contractors, but construction work has been somewhat retarded for the past several months. Contractors do not look for much improvement until late next spring.

The following extracts, taken from reports from widely separated geographical points, are indicative of the general trend of opinion of contractors:

Work in 1929 13 per cent under 1928, which slows up pros-

pects. Industrial building slowed up waiting for market to settle. Any immediate harm done to construction will be overcome. Speculative building will be affected, but will be offset by industrial building. Public works will maintain high level.—*Chicago building contractor.*

Speculative building will be hard to finance. Construction work may be slowed up temporarily.—*Minneapolis general contractor.*

Market condition will stimulate construction, because projects unable to be financed two months ago are now going ahead.—*San Antonio general contractor.*

New work has been delayed pending outcome of market situation. Plentiful capital at lower rates will stimulate all construction work. Labor will be settled, as they are eager to hold jobs. 1930 will be average year.—*Chicago general contractor.*

Industrial building at a standstill due to labor conditions and goods market. Construction will not be back to normal until late 1930 or 1931.—*Greenville (S. C.) general contractor.*

Highway and street work projected shows increase. Building construction outlook favorable, with prospects for good year in 1930.—*Los Angeles A.G.C. office.*

Stabilized bond market means easier financing of permanent construction. Construction industry with allied business interests in West has rare opportunities to serve capital diverted to permanent investment in construction.—*San Francisco A.G.C. office.*

More business expected than if market collapse had not occurred.—*New York general contractor.*

New work offered has fallen off for past several months, but 1929 will be largest in company's history. Five new contracts secured since market crash. Going into 1930 with slightly less work on hand than in corresponding period of 1928. Money will be more plentiful with declining rates, so money will be easier to borrow for construction work. Decline in construction volume will continue into early next year, with improvement coming by summer.—*New York building contractor.*

Some industries whose stock dropped 50 per cent in value are going ahead with construction programs. Will take some time to get going, even if industries and public go ahead with all projects.—*New York general contractor.*

Enough momentum behind construction industry to carry it beyond any hypothetical point of danger.—*New York marine and general contractor.*

Typical Municipal Prospects

***St. Paul*—Considerably more work in 1930 than in 1929.**

***Denver*—Program for 1930 will total somewhat below average year.**

***Jacksonville*—Next year's work will be about average of last ten years.**

Because of the very nature of their business, reports from contractors are based more on opinion than facts.

Of seventeen manufacturers of construction equipment, eleven forecast increases in business during 1930 above this year's level, five look for equal business; one expects a decline. Distributors from widely scattered sections forecast increased sales next year except in New England and southern California.

Only a few trade associations have figures adequate for an estimate of future business. The National Lumber Manufacturers' Association predicts an increase in residential building. The Armco Culvert Manufacturers Association reports that its members have experienced a substantial increase this year and are anticipating greater increase next year. The National Paving Brick Manufacturers Association reports about a 15 per cent increase in 1929 over 1928, and looks for an even better year to follow. The Portland Cement Association believes that road and street work will hold steady, but that a lower building demand may be expected.

One of the largest steel products concerns reports: "Our unfilled orders lead us to believe that our first quarter for the year 1930 will be larger than the first quarter of 1929."

Material handling equipment makers say: "Running full time and shall so continue at least three months"; another company, "We expect to increase our sales 15 to 20 per cent next year"; and a third, "While we feel that there may possibly be some let-down in business for the first quarter of 1930, due to present conditions, at the same time we are planning on an increase of 25 per cent in our production."

The prevailing opinion of the effect of the stock-market decline is expressed by a well-known maker of concrete mixers, who states: "It is our opinion that, rather than injuring our particular line of business, we shall probably benefit somewhat from the Wall Street situation, due to the fact that more capital will undoubtedly find its way through to the building industry." This attitude is re-echoed by the president of a large concern producing excavating machinery. His analysis of the situation reads:

> We see nothing fundamentally wrong which should cause a general recession of business. On the contrary, we feel that the economic structure of our country is much stronger today than it was previous to the break in the market. . . . I believe that business has shown its strength and ability to resist the usual reaction in a break in the market such as we have just had, and, realizing that on the last break in the market in 1921 it took 22 months to reduce loans to the same extent that they were reduced in three days in this crash, I feel that we will have a comparatively quick recovery.

This company, incidentally, increased its sales 32 per cent this year over the corresponding period in 1928, and has just completed a survey of business for the coming year which points to further increases for 1930.

A manufacturer of motors for industrial and construction use reports a depression beginning in March and growing more acute in August, and predicts for next year a volume of 75 per cent of this year's sales. Even this firm, however, sees better times ahead, for it states: "We consider that there is a vital depression on right now and that the country will start coming out of it after Jan. 1. Contracts for our products are being made and are the first optimistic sign in volume we have seen in months."

A maker of flooring used in industrial buildings says: "Our plants are all running to capacity, with sufficient orders to maintain capacity production for 60 days."

Data on this year's operations show the entire industry to be in an unusually strong position. Sales have in general been greater than last year, the figures given varying from 10 per cent down to 32 per cent up, with only three firms reporting decreased sales. The tendency to increase inventories, always found during boom times, has been almost universally resisted; most companies report lower stocks than a year ago.

Equipment Distributors—Distributors in key cities throughout the country report larger sales this year than last, and forecast even greater business in 1930. Easier money is expected to have a quickening effect on public-works construction. Inventories are generally normal or lower.

Outlook for Financing

Immediately after the drop opinion was unanimous that the reaction would be favorable to the construction industry. Interest rates previously had risen to levels that made economical financing of construction difficult, and the collapse of the call money market was therefore expected to release funds for capital investment. This view is borne out by recent developments.

Some mortgage lenders fear overbuilding, and care-

(*Continued on Page 863*)

Fig. 1—Rope-Strand Cable Suspension Bridge With 949-Ft. Main Span at Grand'Mere, Quebec

The Rope-Strand Suspension Bridge at Grand'Mere, Quebec

Structure of 949-Ft. Main Span Is Longest of Type Yet Built—Cable Ropes Cut to Length and Socketed in Shop—Unusual Erection on Ice of St. Maurice River

By D. B. Steinman
Consulting Engineer, New York City

THE new highway toll suspension bridge over the St. Maurice River at Grand'Mere, Quebec, with a main span of 949 ft. is believed to be the first large suspension bridge in Canada and the longest rope-strand cable bridge in the world. A number of other novel features characterize both the design and the erection of the structure. The use of rope-strand cables is unique in a structure of such long span. In addition to this, a special bridge floor of laminated redwood covered with an asphalt wearing surface is used; the end bearings of the stiffening trusses are seated directly on the main pier inside the main tower legs; and flat plates instead of eye-bars are used in the anchorages. Steel and cable erection was commenced and completed in the winter season, the freezing of the river governing the choice of erection methods. In spite of the rigors of the northern climate, new erection speed records were established.

A demand for a bridge at this point was foreseen by the management of a local paper mill, the Laurentide Company, when in 1913 it began a hydro-electric development below the present bridge site which would raise the water level of the river about 35 ft. Because of this depth of water and the soft nature of the riverbed, it was decided that a suspension bridge would be most practicable, and in order to avoid additional expense later, the main piers were built at that time for a bridge with fixed-base towers. Also, in order to facilitate the passing of pulpwood logs to its paper mill, the Laurentide Company constructed in 1917 the approach span of 155 ft. between the west pier of the main bridge and the west bank of the river. In 1927 the city authorities decided to go ahead with the completion of the bridge, and designs were made and bids submitted on a cantilever structure with concrete roadway for two lines of 20-ton trucks. The lowest bids obtained were considerably in excess of $500,000, and this project finally was abandoned in favor of the present design.

The Grand'Mere bridge is a stiffened suspension structure with straight backstays. Its principal dimensions and details are shown in Fig. 2. An 18-ft. roadway is provided, consisting of laminated redwood with a normal thickness of 6 in., laid with ½-in. crown and covered with 1¾ in. of asphalt. Sidewalks on either side consist of 2¾-in. creosoted fir, covered with a brush coat of hot asphalt and a sprinkling of fine-screened gravel. The stiffening trusses were shipped in two-panel lengths, 24 ft. 4 in. long. A half-through section was adopted, with the under side of the top chord far enough above the sidewalk to leave the view of the river unobstructed.

The end-bearings of the stiffening trusses, designed to

permit expansion while resisting possible uplift, are seated directly on the tops of the main piers. The expansion bearing consists of a 6-in. square pin, with ends turned to 5¾-in. diameter, sliding between lubricated phosphor bronze bushings in a rectangular slot in the cast-steel bearing pedestal. Medium-carbon steel is used throughout the structure.

Design Loading—The floor system is designed for a standard loading of two lines of 15-ton trucks. The cables and the stiffening trusses are proportioned for a loading of 60 lb. per sq.ft. covering the entire roadway and 12 lb. per sq.ft. covering the sidewalks, in accordance with the specified U-80 loading of the Canadian Engineering Standards Association. In addition, the structure is proportioned to withstand a wind load of 35 and 25 lb. per sq.ft. on unloaded and loaded spans respectively, and temperature stresses for a range of 80 deg. F. from a normal temperature of 40 deg. F. The cables are designed for a total dead load of 2,430 lb. and a specified live load of 1,152 lb. per linear foot of bridge.

Cables and Suspenders—Each of the two main cables contains 37 galvanized steel strands 1¼ in. in diameter, each strand made up of 35 acid open-hearth steel wires as follows: center wire, 0.192 in. diameter, followed by six wires 0.182 in. diameter, six wires 0.148 in. diameter, six wires 0.197 in. diameter and sixteen wires 0.195 in. diameter. The total sectional area is 0.9559 sq.in. and the weight per foot is 3.38 lb.

When the strands were measured under specified tension (20,000 lb.) for cutting to length, they were marked at calculated points corresponding to tower centers and span center. Two strands for each cable also were marked at the cable band centers, these marks to serve as guides in placing the bands. Special sockets were placed on the strands before shipment. The specified tolerance in length variation was ½ in., and variations in length were adjusted by placing shims in front of the socket bearings. The application of the method of using galvanized bridge strands cut to a specified length when measured under tension, in connection with a special design of anchorage assembly, was developed by the John A. Roebling's Sons Company, Trenton, N. J.

The minimum ultimate strength for each strand was specified at 180,000 lb. and showed 199,000 lb. in tests. The minimum guaranteed modulus of elasticity for the strands was specified at 21,000,000 lb. per sq.in.; tests yielded values exceeding 25,000,000 and the design computations were based on a modulus of 24,000,000. The 1¼-in. diameter galvanized-steel suspender ropes are made up of six strands of seven wires each placed around an independent wire rope center. Each of the strands has a center wire 0.139 in. in diameter surrounded by six

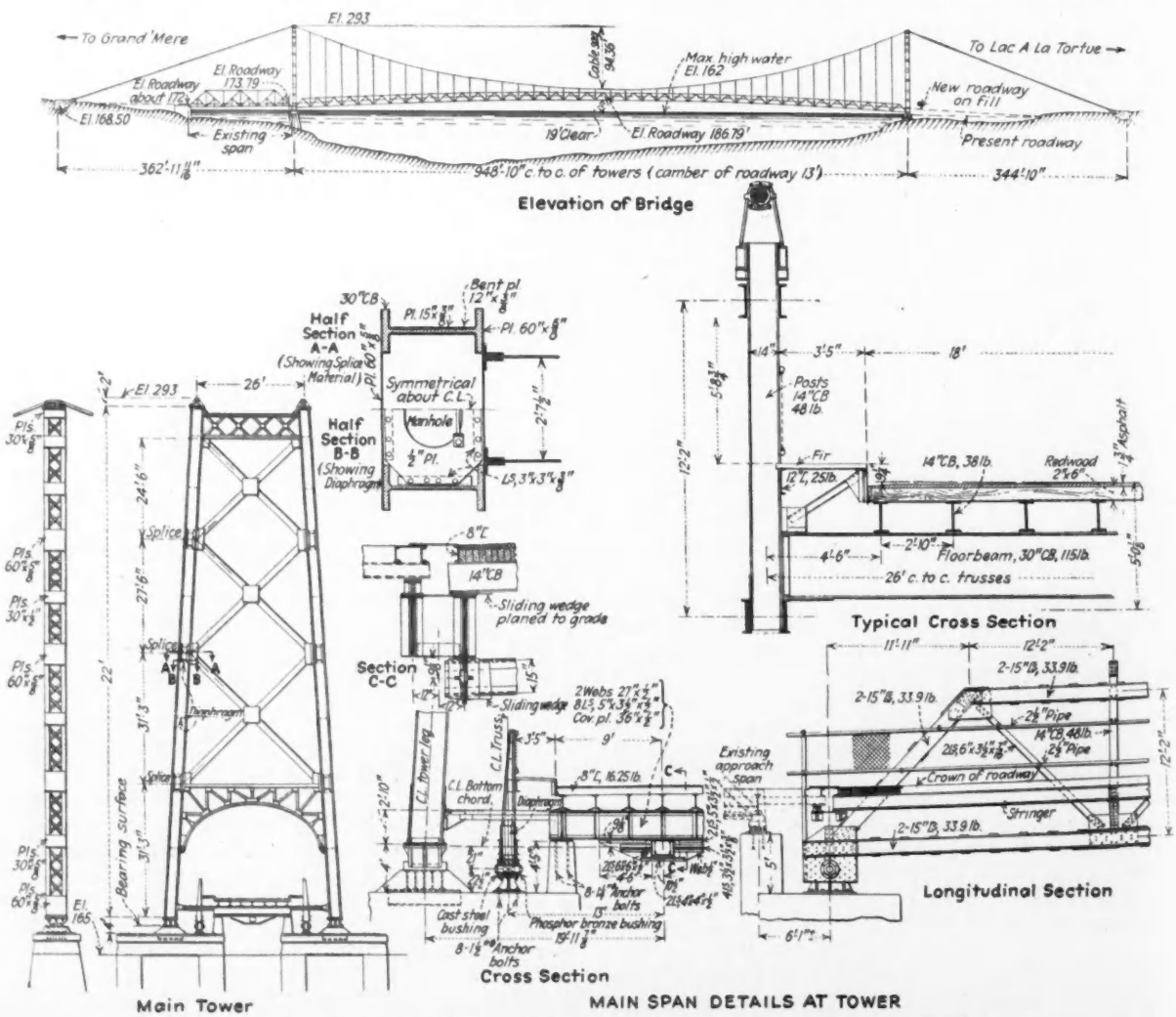


FIG. 2—DETAILS OF LONG-SPAN ROPE-STRAND CABLE SUSPENSION BRIDGE

wires 0.137 in. in diameter. The independent wire rope center has a center strand composed of seven wires of 0.056-in. diameter surrounded by six outer strands each consisting of a center wire 0.054 in. in diameter and six outer wires 0.051 in. in diameter.

Main Towers—The main towers are of the rocker type, each tower leg being made up of two 30-in. rolled beams connected with double lacing and tie plates and stiffened with transverse diaphragms. The tower sections were completely assembled in the shop, the holes for field connections reamed to metal templets and the connecting parts match-marked before shipment to the bridge site. The towers were erected leaning about 18 in. toward the anchorages.

Anchorages and Strand Assembly—The cables are anchored into the solid rock on each side of the river by a system of plates connected to steel grillages embedded in concrete. There is 500 cu.yd. of concrete in each anchorage, exclusive of the exterior concrete housing placed after the cables and span were completed. For additional security, the concrete in each anchorage is anchored to bedrock with twenty 2-in. fox-bolted steel dowel rods, 20 ft. long.

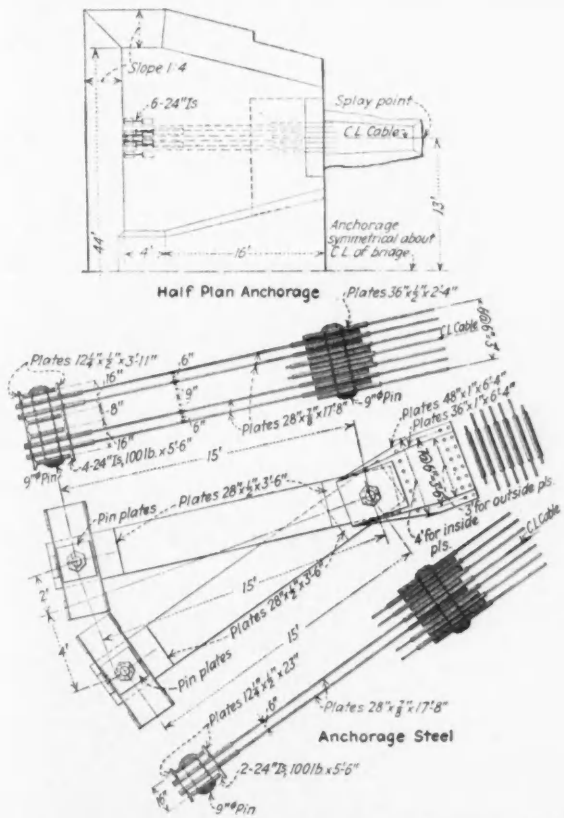


FIG. 3—ANCHORAGE DETAILS, GRAND'MERE BRIDGE

As shown in Fig. 3, six 28x$\frac{7}{8}$-in. plates connect the Y-point of the anchorage steel to the anchor grillages. At the Y-point a 9-in. pin holds a nest of seven vertical anchor plates, 1 in. thick and 6 ft. 4 in. long, each reinforced with two $\frac{1}{2}$-in. pin plates; the five inner plates are 48 in. wide and the two outer plates are 36 in. wide. The special bearing block steel castings are secured between these anchor plates by means of sixteen $1\frac{7}{16}$-in. diameter bolts; twelve of them in each assembly go through all seven anchor plates, whereas the four others pass through only the five wider plates. The bearing blocks between the plates have bell-mouthed semicircular grooves top and bottom between which the $1\frac{1}{4}$-in. cable strands are held by the abutting strand sockets. U-shaped shims are placed between the sockets and the bearing blocks for adjustment of strand lengths.

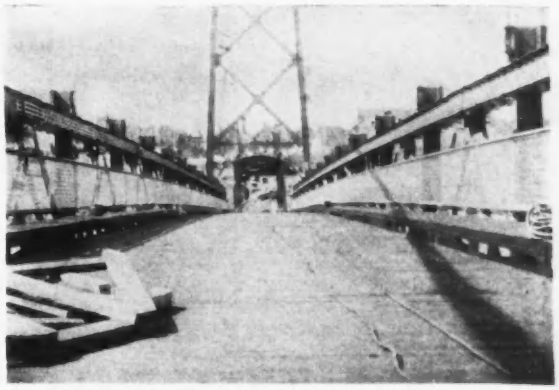


FIG. 4—FLOOR OF LAMINATED REDWOOD PREVIOUS TO PLACING ASPHALT WEARING SURFACE, GRAND'MERE BRIDGE

Erection Methods—Erection of the Grand'Mere bridge involved interesting methods, not only because of the use of rope-strand cables but also because of the extraordinary climatic conditions prevalent during the period of erection. Practically all of the major construction operations were carried on during November, December, January and February. While in many respects the weather retarded progress of the work, in other ways it expedited the erection, for the freezing of the river with a 24- to 30-in. layer of ice was the governing factor in the choice of cable and truss erection methods.

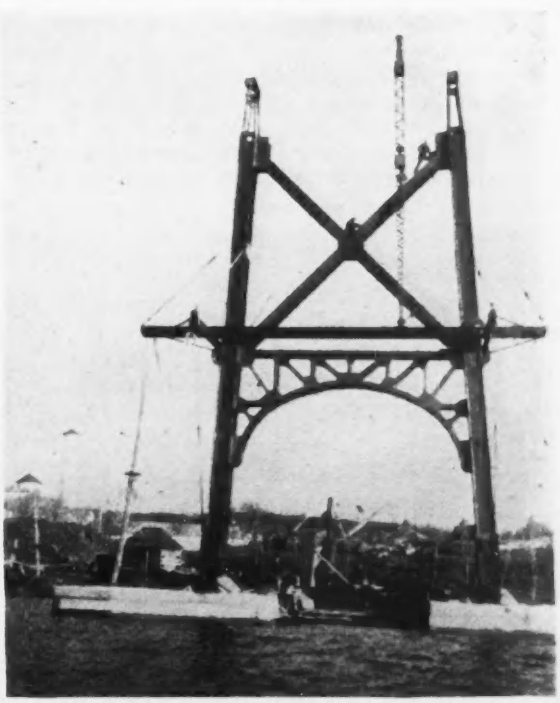


FIG. 5—JUMPINGJACK CREEPER ERECTING TOWER OF GRAND'MERE BRIDGE
Headframes on top of tower legs used to hoist creeper.

FIG. 6—ROPE-STRAND CABLE ERECTION, GRAND'MERE BRIDGE

One strand of either cable in place. Remaining strands strung along wooden horses on ice. Erection procedure was to engage the socket of a strand in the anchorage and lift it to the saddles by means of falls from the top of the towers.

The main towers of the bridge were shipped to the site almost entirely dismantled, so that the heaviest piece, the portal strut, weighed only 5 tons. The lightness of the members permitted the use of a light creeper traveler or jumpingjack consisting essentially of a steel ginpole guyed to a steel frame which was hoisted up the tower as the erection progressed. Three jumps of the traveler were necessary to complete the erection, including the placing of the cast-steel saddles. The towers, of the rocker type, had to be tied to the piers during construction, and as the tower grew in height further stability was assured by the use of timber struts and wire rope guys.

When completely erected, the towers were leaned back the theoretical amount required by the unloaded cable calculations, and the first two strands, one in each cable, were hoisted into place, adjusted to marks on the tower saddles and their positions checked with the transit.

Theoretically the 37 strands in each cable were of 30 different lengths. For cutting purposes the strands were modified so as to make a smaller number of different lengths. Each strand, about 1,680 ft. long, was shipped on a reel which was placed in a frame at the west end of the bridge. As the strand was unreeled, the free end was hauled across the ice by a line from an electric winch located at the east anchorage, the strands being kept free of the ice by wooden horses about 6 ft. high spaced about 30 ft. apart. After the strands were thus laid out, the sockets were fastened to the anchorage connections and the strands, one at a time, were then wired to a balance beam at each tower and hoisted to their position in the saddles by sets of falls hung from A-frames on the tops of the towers. The first strand in each cable was the guide strand, all of the others being adjusted to it. Above the main cable there was strung a $\frac{7}{8}$-in. diameter carrier cable along which were run the cages and chains used in adjusting the strands, placing the cable bands and suspenders, and finally painting the cables.

The truss sections were shipped to the site in two-panel lengths, varying in weight from 7 to 10 tons. Each section was placed on a sleigh at the railroad yard and pulled by horses on the ice to its proper position in the span. It was then fastened to two sets of falls, hanging from the cable, one near each point of suspender connection. Each set of falls had an independent lead line running through a snatch block, which was fastened by a wire rope loop to a deadman under the ice to a double drum engine located at the main tower. There were two such layouts, permitting symmetrical truss erection from the center of the main span toward the towers. Completion of the erection followed usual methods.

Cable Wrapping—In order to fill out the hexagonal section of the assembly of 37 strands into a circular section, segmental redwood strips, $\frac{1}{2}$ in. thick, were placed immediately in advance of the application of the wrapping wire. These redwood strips were soaked in boiling linseed oil before placing. The final cable wrapping consisted of a continuous serving of No. 9 soft-annealed

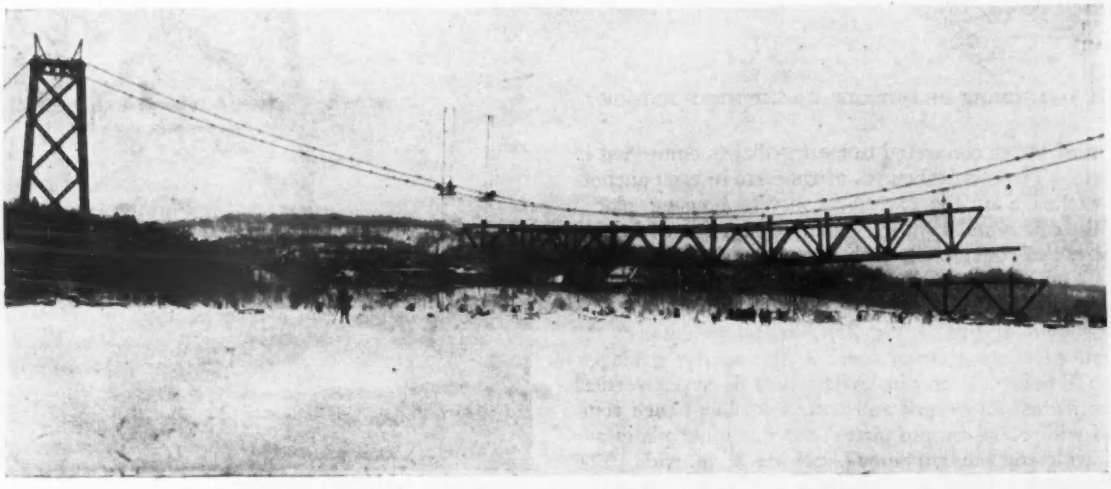


FIG. 7—LIFTING THE STIFFENING TRUSSES INTO POSITION

The truss steel in two-panel lengths delivered on sleighs from railroad yards to location in bridge. Falls attached near the suspender points hoisted the truss sections into place.

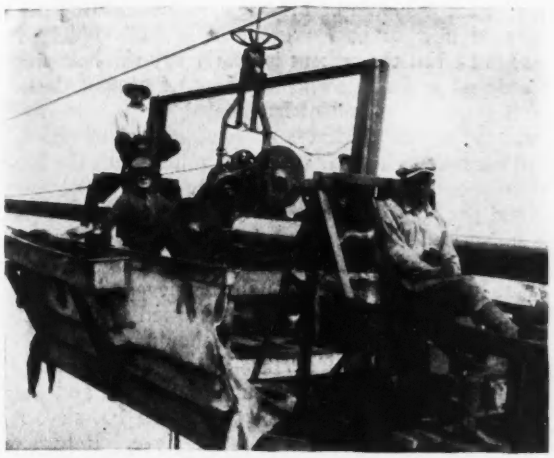


FIG. 8—CABLE-WRAPPING MACHINE IN OPERATION ON GRAND'MERE BRIDGE

double-galvanized steel wire. After wrapping, the cables, cable bands, suspender ropes and all attachments were given one coat of red-lead paint and two finish coats of lead paint tinted to match the light green color of the structural steelwork.

Load Tests—On May 4, 1929, the completed structure was subjected to a load-deflection test by placing two trucks weighing 22 tons at midspan. The calculated deflection for this concentrated loading was 3 7/16 in. and the measured deflection was 3 1/16 in. Careful measurement taken in the early morning when there was no sun showed the under sides of both top chords at midspan to be within 1/16 in. of each other in elevation.

Engineering and Construction—The Grand'Mere bridge was designed by Robinson & Steinman, consulting engineers, New York City, and was constructed under their direction. They were retained with the approval of the province, the city and the Laurentide Company, by Fraser-Brace, Ltd., of Montreal, which concern built the bridge under a lump sum contract. The work was subject to the official approval of Ivan E. Vallee, chief engineer of the Department of Public Works of the Province of Quebec, Canada. P. L. Pratley, of Monsarrat & Pratley, consulting engineers, Montreal, represented the city and the province in reviewing the design and construction. E. B. Wardle, chief engineer of the Laurentide Company, was appointed supervising engineer of the project, and J. A. Bernier, city manager of Grand'Mere, was named as his assistant. L. G. Cox was local superintendent for Fraser-Brace, Ltd. R. Boblow, who prepared the erection sections of this article, was resident engineer for Robinson & Steinman.

The lump sum fee paid to Fraser-Brace, Ltd., for the construction of the bridge was $375,000. The project was financed by the city by means of bonds guaranteed by the provincial government, which also agreed to be responsible for one-half of the annual deficit if any, including provision for sinking fund, the city being responsible for the balance.

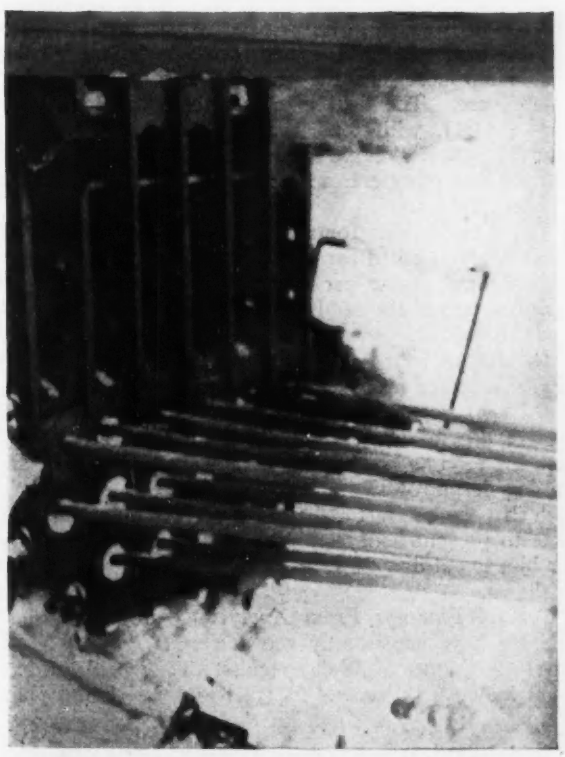


FIG. 9—CONNECTION OF ROPE STRANDS TO ANCHORAGE STEEL

Dry-Weather Sewage-Flow Divertors to Philadelphia Interceptors

Extract from paper on "Sewage Treatment for Philadelphia," presented at the recent meeting of the American Society for Municipal Improvement by John E. Allen, principal assistant engineer, Bureau of Engineering and Surveys.

INTERCEPTION of dry-weather flow from the combined sewers of Philadelphia for the purpose of carrying it to the treatment works is effected by three types of apparatus. For the smaller sewers, where the flow is not affected by backwater, the usual slot in the bottom of the sewer intercepted, with an adjustable lip plate, gives sufficient control, since the small capacity does not permit storm conditions to cause a noticeable fluctuation at the treatment plant.

For sewers ranging from 4 to 10 ft. in diameter, there was designed a tilting gate, operated from the pressure of the flowing stormwater on unequal surfaces exposed to such flow. This type was of use only where backwater was not a factor and where the flow was free from debris.

For large outfall sewers up to sizes 25 ft. in diameter or 12x16 ft. in rectangular section, and where they were subject to backwater or tidal influence, a mechanical gate arrangement of new design operates by water pressure from city mains. Passage through the combined sewer is normally closed by a horizontal sluice gate whose action is controlled by a horizontal hydraulic cylinder. The tidewater is thus held from reaching the connection to the collecting sewer. The diversion passage to the sewage collector is provided with a vertical sluice gate, normally open and connected for simultaneous operation with the tide gate. When the flow increases under storm conditions, a float actuates a valve admitting city water to the hydraulic cylinder and opening the gate on the combined sewer. At the same time the smaller gate on the sewage collector is closed. Upon subsidence, the reverse action takes place. Forty-five miles of these collecting sewers with some of these devices has been completed and 60 miles is to be constructed.

A Substitute for the Compression Test of Concrete

A Method for Determining the Composition and Quality of Concrete While in Its Plastic State

By George J. Griesenauer
Cement Tester,
Chicago, Milwaukee, St. Paul & Pacific R.R. Co., Chicago

During the construction last summer and fall of a concrete chimney and fan house, built by contract for the Chicago, Milwaukee, St. Paul & Pacific Railroad Company at one of its roundhouses in Chicago, the writer conceived the idea of analyzing concrete while yet in its plastic condition to check its actual composition against the contract specifications. Actual trial of this idea proved its success. The specifications called for a 1:2:2½ field mix, with 4.5 gal. of water per sack of cement added at the mixer. H. Wuerth, division engineer, was in direct charge of the work, under D. C. Fenstermaker, district engineer; W. H. Penfield, engineer maintenance-of-way, and C. F. Loweth, chief engineer.

The Method—About 50 lb. of concrete taken at the mixer is used in part to make a 6x12-in. cylinder for the compression test, while 10 to 15 lb. for analysis is shoveled into a friction-top pail which is closed tightly to prevent loss by evaporation. The analysis can be made any time before the concrete hardens; setting can be delayed by storing in a cool place.

To analyze, weigh pail with sample, remove the cover and dig the concrete loose with a putty knife or other suitable tool and pour it into a pail of about 3-gal. capacity, being careful not to lose any of the sample. Wash the friction-top pail clean and pour the wash water into the washing pail, which now contains the entire sample. Dry the empty pail and cover, weigh, and deduct from the gross weight to obtain the net weight of the original sample.

Pour enough water into the washing pail to cover the sample well and stir with hands to produce a fluid which, after allowing to settle for a few moments, pour off into another pail (also about 3-gal.), being careful not to lose any of the decanted liquid nor to allow sand and gravel to flow along. Repeat this washing operation until the cement is washed out and collected in the second wash-pail. Now place the washed sand and gravel in the first wash-pail on a pad of newspapers to dry, transferring to a fresh pad now and then to facilitate drying; in this transfer do not lose any of the fine sand and cement residue adhering to the damp newspaper.

In a few minutes the cement-water mixture will have settled clear and can be poured off carefully. Filter paper can be used for this decantation if advisable. When the clear water is poured off to a point where the cement is about to be carried along, the pouring operation is stopped and the remainder is agitated and poured into a low vessel, such as an ordinary wash pan. It will require two or three rinsings of the pail into the wash-basin to clean the pail of all trace of the cement. The basin consequently will contain an excess of water, which can be poured off after a short settling. The basin containing this cement slurry is now ready to set on a gas burner to evaporate the water from the cement. It can be kept at a rolling boil until evaporated to a cakelike mass, when it should be broken up. The heating can be increased now to hasten evaporation to complete dryness; but when the cement is nearly dry the heat should be reduced again to avoid any loss of cement dust.

After the dried cement has cooled, place it in installments on several thickness of newspaper and pulverize it with a round glass jar used as a rolling-pin; the lumps pulverize easily. A brush with fairly stiff bristles should be used to clean the pan of all adhering cement. Screen the pulverized cement through a 100-mesh sieve, again crush the residue, screen and repeat until all of the cement has been passed through the sieve. The residue of fine sand held on the sieve is returned to the washed sand and gravel, which by this time should be surface-dry.

Place the mixture of surface-dry sand and gravel on a No. 4 sieve to separate the sand and gravel and weigh the gravel. Next screen the sand on the 100-sieve and weigh as sand what is held on the sieve. Return the amount passing the sieve to the cement, and weigh the cement. This completes the analysis.

Illustrative Case—A recent analysis showed:

Gross weight of concrete, lb.	11.328125
Weight of container, lb.	0.609375
Net weight of concrete, lb.	10.718750
Analysis	
Cement, lb.	1.843750
Sand, lb.	3.062500
Gravel, lb.	4.953125
	9.859375
Water by subtraction, lb.	0.859375
Total, lb.	10.718750

As the sample by analysis contained 1.84375 lb. cement, while a sack contains 94 lb., the analysis values are reduced the one-sack basis by the factor 94 ÷ 1.84375 = 50.98.

	Lb. Per Sack Cement
Cement, 1.84375 × 50.98	94.0
Sand, 3.0625 × 50.98	156.25
Gravel, 4.953125 × 50.98	252.5
Water, 0.859375 × 50.98	43.81, or 5.26 gal.

Tests made showed the sand to weigh 90 lb. per cubic foot damp loose, and the gravel 110 lb. per cubic foot damp loose. The field mix therefore was 1:1.74:2.3 (= 1:4.04), with total water 5.26 gal. per sack of cement. Abrams' curve shows that a W/C ratio of 5.26 gal. per sack represents a strength of 3,625 lb. per square inch at 28 days.

The specifications for the concrete represented in the above analysis called for a 1:2:2.5 (= 1:4.5) field mix with 4.5 gal. water per sack added at the mixer. A moisture test of the sand used the day this analysis was made showed 2.2 per cent moisture. The gravel was not tested for moisture that day, but its moisture content can be assumed at 1 per cent. This would equal 6 lb., or 0.72 gal., water added by the aggregate, a little below the average; adding it to the 4.5 gal. mixer water checks with the total amount shown by the analysis. The reinforcing design of the structure at the point of use was such that the contractor desired a very free-flowing concrete to prevent honeycombing, and so it was necessary for him to cut down a little on the specified proportions, as shown.

General Findings From Analysis—Value from such analyses have consistently shown results corresponding closely to the actual 28-day results. Tests made at frequent intervals on several contract jobs for this railroad company, to keep a check on the actual quality of the concrete, have been a real help toward uniformity and quality of the concrete in the structure, the writer believes.

A few comparative tests made at different times, including the first test made by this method (first in table), are:

Class of Concrete	Water Per Sack, Gal.	Compressive Strength, Lb. Per Sq.In. by Test at 28 Days	Lb. Per Sq.In. by Analysis of Plastic Concrete
1 : 2 : 2½	4.5	3,785	3,480
1 : 2 : 2½	4.5	3,360	3,350
1 : 2 : 2½	4.5	3,500	3,400
1 : 2½ : 3	5.5	2,880	2,850

The practice has been to take a sample of the concrete placed during the latter part of the day and make the analysis in the early evening before the sample hardened, thereby ascertaining its actual quality and composition before the next day's work.

The method appears to be of value for several reasons as suggested by the foregoing: it gives us information regarding the quality of the concrete in a few hours at most, instead of waiting for the 28-day test; it eliminates the work and cost incident to making and testing the concrete cylinders.

This idea of unscrambling plastic concrete was conceived by the writer about a year ago and tried out some time later—by crude means, as will be observed—and is still so done. Refinement and improvement should give us even more quickly the important facts on quality and composition of the concrete *during its manufacture.*

Precast Concrete Bridge Railing Design Allows Future Shift

Heavy Sections Bolted to Floor Slab Combine Safety With Movability When Traffic Requires Roadway Widening

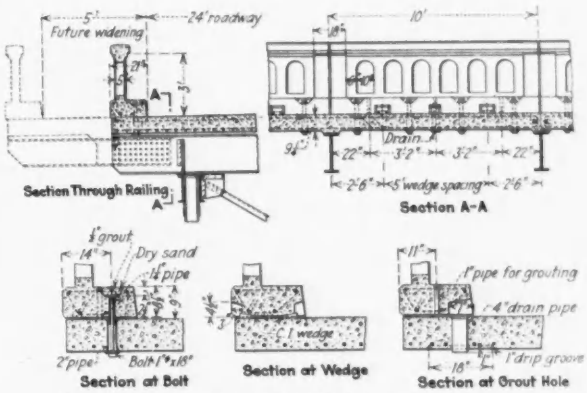
A PRECAST concrete bridge railing that can be shifted to a new curb line when future traffic requires a wider roadway has been designed for the new Salinas River bridge at San Ardo by the California Division of Highways. The present roadway, carried on ten 100-ft. steel deck spans and seventeen reinforced-concrete spans 37 ft. long, has a width of 24 ft. between curbs, but the design provides for a future 5-ft. cantilever section to be added on each side. This necessitated a railing adequate for present safety requirements and capable of being later removed to the new position without interference to traffic.

A concrete railing was adopted for the section of bridge carried on steel spans, in place of a steel rail, to make it conform to the railing of the concrete approach spans and give a more uniform appearance to the structure. Precast concrete railing was selected primarily because of the possible future shift but also to aid in rapid construction, since the sections of railing can be poured in advance without delaying or complicating the roadway slab construction. Safety requirements were met by designing the rail and fastenings for an impact of 1,000 lb. per linear foot. In cross-section the railing has an L-shaped base that provides the roadway curb and a place for the anchor bolts. The railing will be cast in 10-ft. sections.

Alignment, after placing the section of railing at the edge of the slab, will be accomplished by means of cast-iron wedges under the base. Wedge pockets (see detail) are provided in pairs at the third points of each 10-ft. section. The wedges, 4x5x1½ in. thick, will be driven between base and slab to secure proper alignment, and afterward the pockets will be filled with grout.

After aligning, bearing between railing base and slab will be secured by grouting with a grouting machine through three 1-in. pipe holes left in the base. In addition to providing bearing, this joint also will divert drainage along the curb to the drain holes through the slab located at 20-ft. intervals. After grouting, the holes will be filled with dry sand and grouted over.

Anchorage between railing sections and the roadway slab is secured by bolts through the side, or curb portion, of the base and the slab. Provision for the bolts is made by inserting pieces of pipe at the proper points



FEATURES OF RAILING DESIGN THAT PERMIT FUTURE MOVE

before the pour. The four bolt holes in each 10-ft. section are spaced at 1-ft. 3-in. intervals and are staggered with the wedge spacing. The hole in the slab is made by a 2-in. pipe belled out slightly at the lower end for anchorage. The hole through the base is formed by 1¼-in. pipe that ends 2½ in. from the top of the base at the bottom of a recess 4 in. square provided to hide the nut. One-inch bolts with washers will be used to anchor the railing, and after they are tightened the recess in the base will be filled with dry sand to within ½ in. of the surface and then grouted over.

The probable sequence of the future widening is planned to consist of the following steps: The floor-beams will be extended 5 ft. each way by splicing a cantilever onto the ends of original beam; rivet holes for this splice will be provided at this time. The slab extension may then be poured, after which the railing will be moved over to the new position and anchored with the same type of fastening as before. This widening process is designed to be carried out without causing interference to traffic on the original roadway.

The designs were prepared in the office of C. E. Andrew, bridge engineer, division of highways, California Department of Public Works. C. H. Purcell is state highway engineer. B. C. Gerwick, San Francisco, is the contractor.

Electrically Welded Bridge Opened in Poland

An electrically welded bridge was recently opened officially in the district of Warsaw, Poland. Its length between supports is 27 meters and its weight is said to be 15 per cent lighter than the weight of similar riveted bridges. The construction was made according to plans prepared by a Polish professor.

Terracing to Combat Soil Erosion Losses

Department of Agriculture Is Conducting Field Studies of Different Forms and Spacings of Terraces—First Work in Oklahoma Red Lands

By C. E. Ramser
Senior Drainage Engineer
U. S. Department of Agriculture, Guthrie, Okla.

MILLIONS of dollars are lost to the farmers of the United States each year through soil erosion, or the washing away of earth by water. Soil losses from this cause occur in every state of the Union and in almost every county. Large-scale field studies of preventive methods are now being carried on by the U. S. Department of Agriculture to put a stop to these losses.

In 1927 the Bureau of Chemistry and Soils estimated that no less than 10,000,000 acres of formerly cultivated land has been rendered permanently unproductive by soil erosion and an additional 3,000,000 acres of formerly productive bottom land has been made worthless or seriously impaired by overwash of more or less inert sands and gravels deposited from flood, and by increased swampiness due to the added overflow caused by the clogging of stream channels with silt, sand and gravel. So serious is the condition that N. S. Shaler, formerly

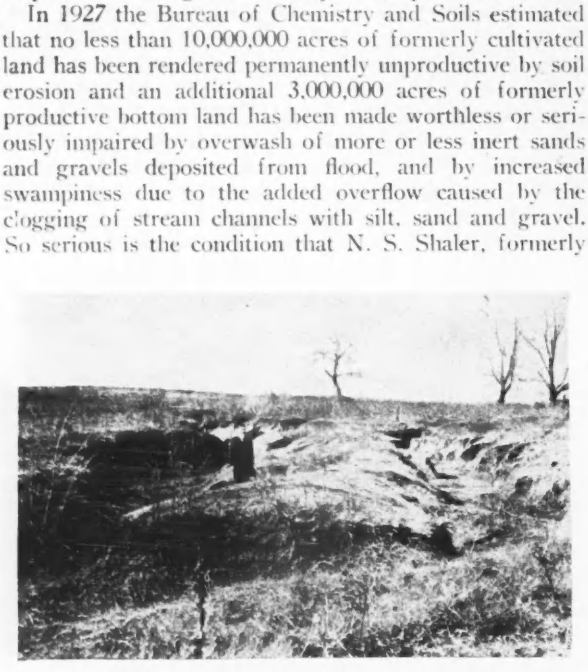


FIG. 1—GULLYING, WHICH CAUSES LOSS OF LAND AND LOWERING OF THE WATER TABLE

dean of the Lawrence Scientific School, was once moved to remark that if mankind cannot devise and enforce ways of dealing with the earth which will preserve this source of life, "we must look forward to the time—remote it may be, yet clearly discernible—when our kind, having wasted its greatest inheritance, will fade from the earth because of the ruin it has accomplished."

Erosion injures fertile lands in a number of ways. The upper and most fertile parts of the soil are washed away until the land becomes barren and unproductive. Deep gullies are formed which mean an actual loss of cultivable land area, and result in a lowering of the water table and a consequent deficiency of moisture in the soil (Fig. 1). Drainage ditches often become filled with sand, which frequently results in the flooding of the adjoining bottom land and the destruction of crops (Fig. 2). Rich bottom lands often are covered by deposits of sand washed from the hill lands. The upland farmer suffers through the loss of the land area occupied by gullies, through smaller crop yields and through continued decrease in the market value of the land. The bottom-land farmer loses because cultivable land is covered with sand,

FIG. 2—DRAINAGE DITCH PARTLY FILLED WITH SAND WASHES FROM ERODING HILLS

crops are damaged by overflows or deposits of sand, the market value of the land decreases and drainage ditches are filled with sand. Thus both the bottom-land farmer and the upland farmer are concerned in checking erosion.

Two General Methods—Soil erosion is due chiefly to the free movement of water over the ground surface. If most of the rainwater were absorbed by the ground upon which it falls, erosion would be greatly reduced. It is obvious, therefore, that to prevent or reduce erosion action, the soil must receive treatment that is conducive to the absorption of large quantities of rainwater, and methods must be employed to reduce the velocity and thereby the transporting and erosive power of the run-off water.

Since the storage capacity of the soil depends upon its porosity, any treatment which results in an increased porosity of the soil will reduce erosion materially. This porous condition can usually be obtained by deep plowing and the thorough incorporation of organic matter in the soil. Methods of subsurface drainage which lower the groundwater level tend to improve the porous structure of the soil and increase its capacity to absorb surface water. Seeding land to meadow or pasture, growing timber or planting cover crops tends to diminish erosion.

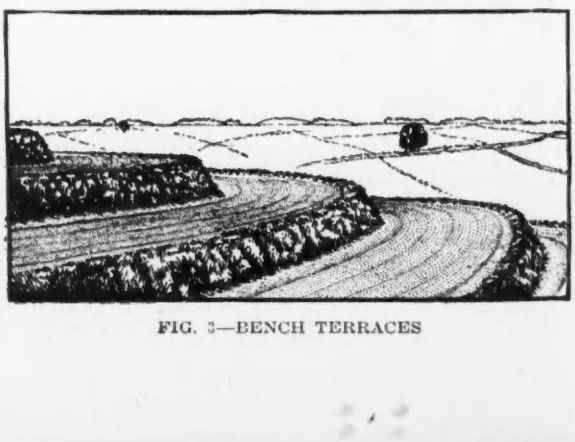


FIG. 3—BENCH TERRACES

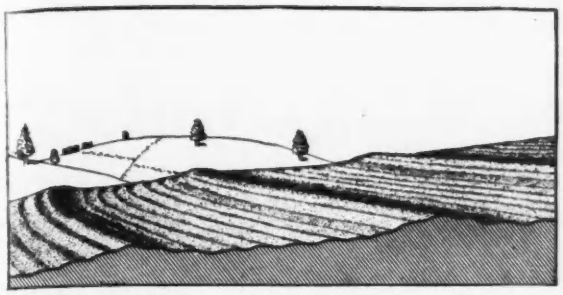


FIG. 4—BROAD RIDGE, OR MANGUM TERRACES
These are simply ridges of earth thrown up across the hillside.

Other methods which retard the flow of the water and reduce erosion are subsoiling, contour plowing and terracing. It is quite generally recognized that terracing is the most effective and dependable method of stopping soil erosion.

True or Bench Terracing—The first terracing consisted of building up the surface of hillside land in a series of level areas resembling stair steps, the intervals between the risers being horizontal and the riser itself being vertical or nearly so. This type of terrace has long been used extensively in Europe, Asia and South America and is still being used to a considerable extent in the southeastern part of the United States. It is known generally as the bench terrace (Fig. 3). Strictly speaking, this is the only true terrace, but the word "terrace" in this country is applied also to ridges of soil constructed in such manner as to prevent the rapid flow of water down the slope.

The bench terrace has never become generally popular with the farmer because of the difficulty of moving farm machinery from one bench to another, the necessity of cultivating each bench separately, the loss of the land occupied by the uncultivated embankment and the growth of weeds and grass on the embankment. Except on steep slopes, cultivable terraces are preferable.

Ridge Terracing—The broad-base ridge terrace, which can be cultivated, is generally known as the Mangum terrace and was originated and developed by P. H. Mangum about 45 years ago on his farm near Wake Forest, N. C. Fig. 4 sketches a field of such terraces. They are built from 15 to 40 ft. broad at the base and from 15 to 24 in. high. The entire terrace is cultivated, leaving no waste land in the field. The original Mangum terrace was built with fall along the terrace

FIG. 5—WATER FLOWING OFF IN A BROAD, SHALLOW CHANNEL OF A MANGUM TERRACE

to carry off water in a broad, shallow channel at a low, non-eroding velocity (Fig. 5). But terraces are sometimes laid out level and the rain that falls on the slopes is collected and retained in the channel until it evaporates or slowly drains off.

To study erosion and terracing the writer made a trip

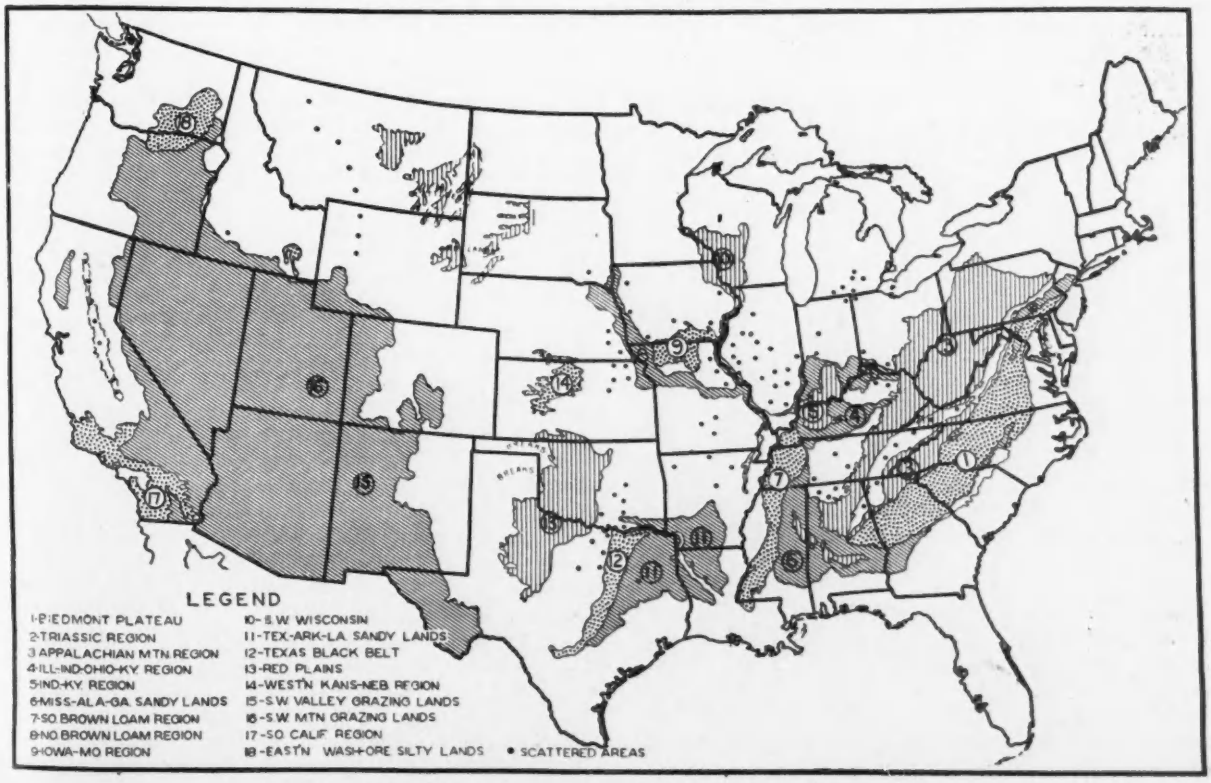


FIG. 6—RECONNOISSANCE MAP OF REGIONAL SOIL EROSION AREAS

during 1914 through North Carolina, South Carolina, Georgia, Alabama and Mississippi, and surveyed many terraced fields to deduce definite instructions for efficient terracing. (Bulletin 512, Department of Agriculture.) A great diversity of opinion existed among the landowners, but in most cases it could be attributed to varying conditions of soil and topography or to differences in farming methods.

Terracing was first extensively practiced in the Southeastern states. Since 1915 the practice of terracing has been coming rapidly into favor in states west of the Mississippi River, and today perhaps the best terracing methods are employed in Texas and Oklahoma. That terracing is regarded as important and essential to the maintenance of land values in Texas and Louisiana is exemplified by the fact that the federal land banks of Houston and New Orleans require that land subject to soil washing be terraced before granting loans.

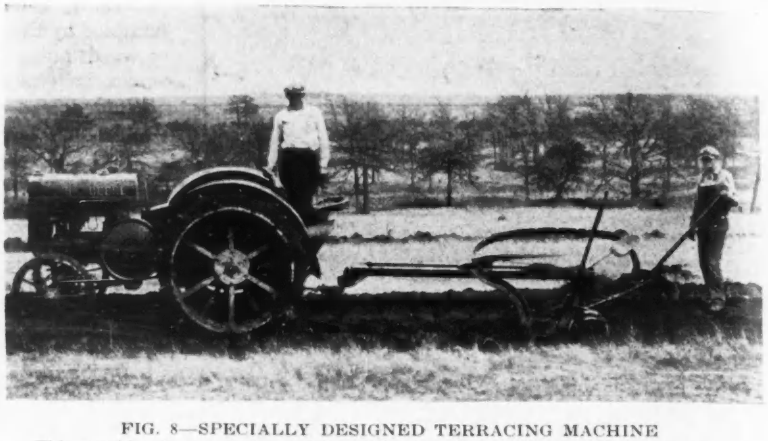


FIG. 8—SPECIALLY DESIGNED TERRACING MACHINE
This machine has a steel revolving disk at each end of the adjustable and reversible cutting blade and mold board.

During 1928 terracing work was done in 31 states, the leading ones being Texas, Mississippi and Alabama (574,000, 155,000 and 151,000 acres terraced). These lands were terraced largely in accordance with principles developed from the results of the investigations referred to above. Experience with terraces built according to recommended practice indicates that there is a need for further research to determine the best methods for different conditions.

Study Authorized by Congress—Last year the widespread public interest that has been shown in soil erosion and moisture conservation led Congress to appropriate $160,000 for soil erosion investigations, $40,000 of this amount to be immediately available. Plans for the work are being developed by a committee comprising A. G. McCall (chairman), chief of soil investigations, Bureau of Chemistry and Soils; S. H. McCrory, chief of the division of agricultural engineering, Bureau of Public Roads; E. H. Clapp, assistant forester in charge of the research branch of the Forest Service; J. G. Lipman, director of the New Jersey Agricultural Experiment Station, and A. B. Conner, director of the Texas Agricultural Experiment Station.

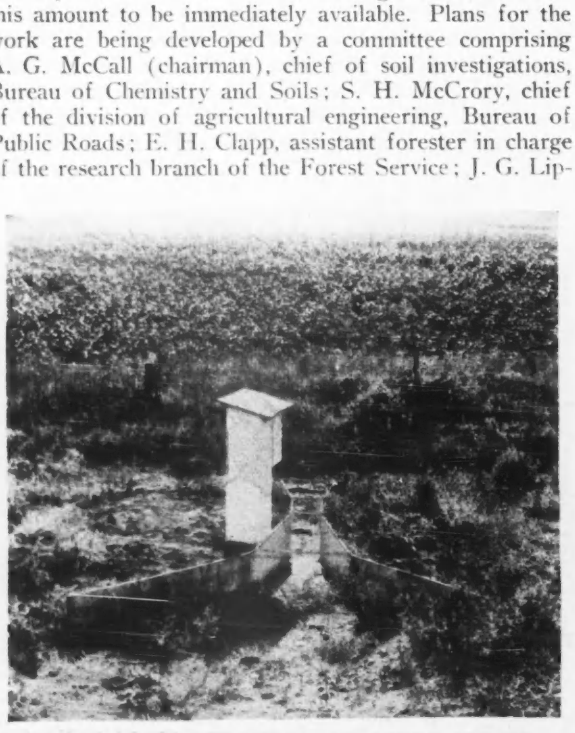


FIG. 7—VENTURI FLUME AND WATER-STAGE RECORDER HOUSE

Soil erosion experimental stations will be located in the principal erosion regions in the United States. As a result of the preliminary reconnoissance survey already made, eighteen principal regions have been outlined, in which erosion stations should be established. The areas outlined are shown on the accompanying map (Fig. 6).

The first station established is located in the Red Land regions of Oklahoma and Texas (13 in the map), 4 miles south of Guthrie, Okla. Work has been in progress here since January, in co-operation with the Guthrie Chamber of Commerce. The second station is near Temple, Tex., in the Black Lands region (12). Work has been in progress at this station since April, in co-operation with the state agricultural experiment station. The location for a third station has been chosen on the state agricultural experiment farm near Hays, Kan., in the dark prairie lands of west-central Kansas (14).

The engineering phases of the study will include investigations on different land slopes and soils to determine: rates of run-off and amounts of erosion, effect of vertical and horizontal interval between terraces, effect of the grade of terraces, maximum permissible length of terraces on different slopes and soils, means of preventing erosion at the ends of terraces, construction methods, effect of farming operations, maintenance methods and the best arrangement of soil-saving dams.

At the Guthrie farm, 160 acres, work was started Jan. 15, and about 15 acres of land has been cleared and partly grubbed, 1,800 ft. of gullies has been filled with brush, 75 acres of land has been terraced with 7 miles of terraces, and 45 brush dams, eight rock dams, four woven wire dams and six pole dams have been built for checking erosion in gullies.

Five sets of terracing experiments have been laid out. One set consists of six terraces 700 ft. in length with a uniform fall of 4 in. in 100 ft. and vertical intervals between terraces of 2, 3½ and 5 ft. The slope of the land varies from 5 to 7 per cent. Two recording rain gages are provided, recording Venturi flumes (Fig. 7) for measuring the run-off have been installed at the ends of these terraces, and silt-measuring devices will be placed at the flumes. The results of these experiments will afford information on the proper vertical interval for terraces for the particular soil and slope, and on the design of the terrace channel.

The second set consists of four terraces 1,500 ft. in length and with grades from level to 6 in. per 100 ft.

The third set consists of five terraces about half a mile long, two located on virgin land and three on eroded and gullied land. For one terrace on each kind of land the grade varies from level to 4 in. in 100 ft. and for another from level to 6 in. The fifth terrace has a uniform fall of 3 in. per 100 ft.

The fourth set consists of three level terraces mostly on virgin soil and on a land slope of about 2½ ft. per 100 ft., two of which encircle the top of a knoll near the center of the farm, while the other has both ends closed so that all of the rainfall is caught and held above the terraces until it evaporates or percolates into the soil. Fig. 8 shows a specially designed machine that is used for terracing work.

The fifth set of experiments consists of ten level terraces varying in length from 200 to 700 ft. and with vertical interval varying from 2 to 4 ft. The average slope of the field is about 4½ ft. per 100 ft. One end of the level terraces is closed and a small embankment is built 100 ft. from the end so that all of the rain that falls on this 100-ft. length is caught and held.

Much information has been collected on the time required in the construction of terraces of different dimensions with different kinds of terracing implements. Comparison will be afforded on the practicability of crossing terraces with furrows or running the rows parallel to terraces.

The principle involved in the design of a graded terrace is that the size and grade of the terrace channel be such that it will conduct the run-off water to a drainage outlet at a non-eroding velocity and without allowing the water to overtop the terrace. Since rainfall is the source of the run-off, a knowledge of the amount, intensity and duration of the rainfall, as well as the time of concentration of run-off, is essential to the satisfactory design of a graded terrace system. It is apparent that the proper design of a graded terrace should be based upon experimental data. At present such data are extremely meager.

Pneumatic Caissons Improvised From Open Cylinders

Steel Trusses Assembled Flat on Staging Alongside Piers and Lifted as Units Onto Concrete Piers

By Phillips B. Tartt
Consulting Engineer, San Antonio, Tex.

THE new international bridge between Del Rio, Tex., and Villa Acuna, Mexico, the superstructure of which was described by the writer in *Engineering News-Record* of Aug. 23, 1928, p. 274, was built by a local contractor inexperienced in this class of work, inadequately supplied with equipment and almost entirely without skilled labor. The problem was to build five concrete I-section piers each on two 6-ft. steel cylinders filled with concrete and to erect on them four 150-ft. steel spans.

The end piers at the water's edge were easily built, the shells being sunk by pumping and excavating inside, allowing them to settle. The sinking of the shells for the three interior piers presented difficulty occasioned by the fact that the streambed of solid rock at a depth of about 13 ft. below water level was overlain by about 6 ft. of coarse gravel and boulders with voids filled with quicksand, and this in turn was overlain with about 5 ft. of quicksand.

The writer had anticipated this difficulty and had designed accordingly, and had explained the proposed pneumatic method of sinking these cylinders to the contractor. However, the contractor was averse to using the method proposed and insisted on attempting to sink by open hand dredging and dewatering by pumps. These attempts were a complete and expensive failure. In view of this experience, it was decided to try the writer's pneumatic method, which was entirely successful. The home-made equipment used is shown by Fig. 2. The whole outfit, exclusive of air compressor and air lines, which were already on the job for operating the riveting hammers, cost about $50.

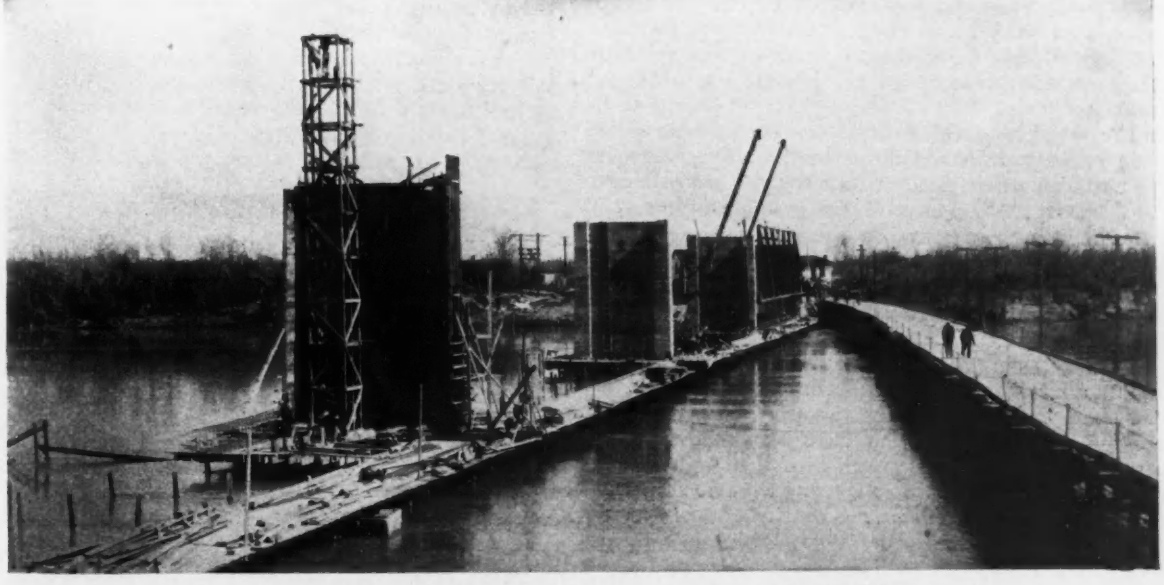


FIG. 1—SUBSTRUCTURE CONSTRUCTION OPERATIONS ON RIO GRANDE BRIDGE

The procedure was extremely simple. The complete cylinder, carefully calked, was lowered into position by a chain block suspended from gallows until it sank through the quicksand under its own weight and rested on the bed of coarse gravel and boulders. It was then realigned if required and the air top set in place and loaded with sandbags. Two men entered through the hatch, closing it after them. Air was applied and maintained at about 4 lb. per sq.in. in the cylinder and excavation proceeded in the normal way. All excavated material was thrown onto the platform indicated for that purpose. When the platform was loaded the men climbed onto it, the air was released gradually and water

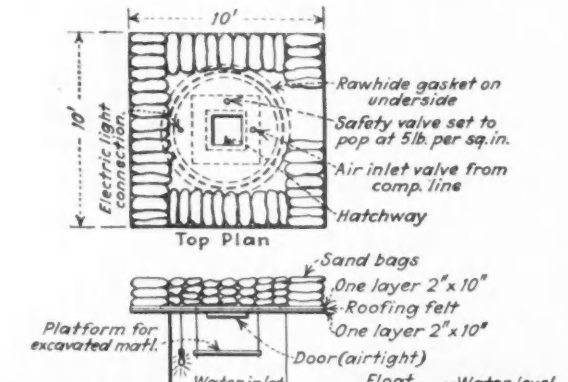


FIG. 2—OPEN CYLINDER CONVERTED INTO PNEUMATIC CAISSON

was allowed to enter through a valve from above to equalize the pressure. As soon as cylinder was full of water and the pressure down to atmospheric, the hatch was opened and the excavated material was removed. The cycle was repeated until the cylinder was resting on bedrock.

The erection of the four 150-ft. steel spans of the main crossing presented the next difficulty. Owing to the character of the bottom, falsework would have been very expensive. In view of the stiffness of the solid rolled section chord members, the writer suggested that the trusses be riveted up on the provisional working platform, which had been built for the convenience of the work on the piers, then carefully raised to a vertical position and set in place on tops of piers.

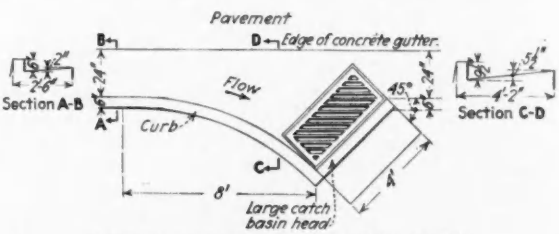
This method was employed with excellent results and no difficulties whatsoever were encountered. When one truss was in place on its shoes it was guyed into position and the companion truss was raised. Wind bracing and floorbeams were then filled in and the next pair of trusses was raised. Stringers were filled in from the American end, advancing over stringers already laid, and the same procedure was adopted with regard to the concrete floorslab. The lowest bid price for the erection of this steel was $32 per ton, while the actual cost by this method was somewhat less than $18 per ton.

The general contractor on the job was H. M. Hutchinson, of Del Rio, Tex. E. A. Hagy, now with the Ferro-Concrete Steel Company, as foreman for Mr. Hutchinson, very ably carried out the writer's idea for the special pneumatic method of sinking the cylinders, and P. G. McGowen, foreman for Mr. Hutchinson, deserves great credit for carrying out the erection of the steel with the limited facilities and unskilled labor available. The bridge is jointly owned by the Citizens Bridge Company, of Del Rio, Tex., and the Cia del Puente Urbano Internacional Acuna, S.A., of which F. N. Garcia, of Piedras Negras, is president. The writer was consulting engineer.

Catch-Basin Inlets on Hillside Street at Maplewood, N. J.

By Herbert W. Heilmann
Township Engineer, Maplewood, N. J.

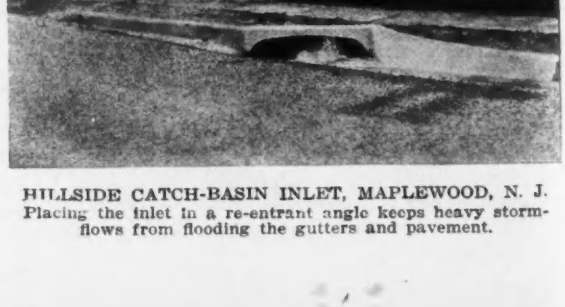
A CATCH-BASIN inlet for storm sewers in hillside streets, set back into an angle extending through the curb and into the parking strip, is shown by the accompanying illustrations. Inlets of this type have been installed under my direction in Maplewood, N. J., on Claremont Ave. between Ridgewood Road and



DETAILS OF HILLSIDE CATCH BASIN

Wyoming Ave. and, in conjunction with cobble gutters, on Durand and Roosevelt Roads.

As shown by the line drawing, the inlet is set at an angle of 45 deg. with the curb line, the curb being changed in alignment for a distance of about 8 ft. and a warped section being formed in the gutter so that the face of the curb increases from 6 to about 9½ in. For the protection of the traveling public, the curb, gutter and inlet are painted with white traffic paint. It is further planned to install gratings over the inlets which will be hinged to the cast-iron head in order to facilitate cleaning the catch basins.



HILLSIDE CATCH-BASIN INLET, MAPLEWOOD, N. J.
Placing the inlet in a re-entrant angle keeps heavy storm-flows from flooding the gutters and pavement.

Meeting Airport Needs With Highway Practices

Drainage Methods and Surfacing Experience in the Highway Field Applied to Airports in Two Papers at American Road Builders' Association Airport Conference

The Municipal Airport Conference held recently in Washington, D. C. by the City Officials Division of the American Road Builders' Association produced two papers that contained data readily usable by the airport engineer in designing his drainage system and determining what types of surfacing will economically and efficiently serve his needs. The papers translate highway practices into airport needs in a very real way and are abstracted below in considerable detail. —EDITOR.

Airport Drainage

BY C. A. HOGENTOGLER AND F. A. ROBESON

Senior Highway Engineer and Junior Highway Engineer, Bureau of Public Roads, Washington, D. C.

THE need for artificial drainage depends largely on both soil character and surface slope. Therefore a preliminary soil survey should be made of prospective sites before a final selection is made. In this survey it will prove beneficial to identify the various soils with respect to the subgrade grouping proposed by the Bureau of Public Roads. The portion of this grouping applicable to airports is summarized as follows:

Group A-1—Well-graded material, coarse and fine, excellent binder. Highly stable under wheel loads, irrespective of moisture conditions. Functions satisfactorily when surface treated or when used as a base for relatively thin wearing courses. Represented by the excellent top soils of Georgia.

Group A-2—Coarse and fine materials, inferior binder. Highly stable when fairly dry. Apt to soften at high water content caused either by rains or by capillary rise from saturated lower strata when an impervious cover prevents evaporation from the top layer.

Group A-3—Coarse material only, no binder. Lacks stability under wheel loads but is unaffected by moisture conditions. Furnishes excellent support for flexible pavements of moderate thickness and for relatively thin rigid pavements. Represented by the Florida sands.

Group A-4—Silt soils without coarse material and with no appreciable amount of clay. Apt to absorb water very readily in quantities sufficient to cause rapid loss of stability even when not manipulated. When dry or damp, presents a firm riding surface which rebounds but very little upon the removal of load, due to capillary pressure acting upon its surface. Apt to cause cracking in rigid pavements due to frost heaving and failure in flexible pavements due to low support. Represented by the New Hampshire silts.

Group A-5—Similar to Group A-4, but furnishes highly elastic riding surfaces with appreciable rebound upon removal of load even when dry. Elastic properties interfere with proper compaction of macadam during construction and with retention of good bond afterward. Represented by highly micaceous soils of North Carolina.

Group A-6—Clay soils without coarse material. In stiff or soft plastic state absorb additional water only if manipulated. May then change to liquid state and work up into the interstices of macadams. Furnish firm support essential in properly compacting macadams only at stiff consistency. Deformations occur slowly, and removal of load causes very little rebound. Shrinkage properties, combined with alternate wetting and drying under field conditions, are apt to cause cracking in rigid pavements. Represented by the Mississippi gumbo.

Group A-7—Similar to Group A-6, but when moist, deforms quickly under load and rebounds appreciably upon removal of load. Thus lacks firmness in support, similar to subgrades of Group A-5. Alternate wetting and drying under field conditions leads to even more detrimental volume changes than in Group A-6 subgrades. May cause concrete pavements to crack before setting and to crack and fault afterward. Represented by Illinois gumbo and typical adobes.

Group A-8—Very soft peat and muck incapable of supporting a road surface without being previously compacted or displaced by a fill. Represented by Michigan peat bogs.

Group B-1—Non-uniform natural ground due to abrupt variation in soil characteristics or soil profile, or to frequent change in field conditions.

FIG. 1—EIGHT 12-IN. OILED CINDER RUNWAYS AT CHICAGO MUNICIPAL AIRPORT

From the results furnished by the preliminary soil surveys, a site should be selected in which the groundwater elevation is low and where, if possible, the soil consists of either a porous poorly graded material of Group A-2 variety or a porous material underlain with cohesionless sand or gravel, Group A-3. Furthermore, a slight grade is desirable with respect to drainage. Assuming that artificial drainage is found to be necessary, the preliminary soil survey should be supplemented by a very thorough examination of those parts of the field requiring drainage. Such an examination should serve to disclose the groundwater elevation and the arrangement, thickness and permeability of the zones comprising the soil profile. Borings and test pits 5 to 10 ft. deep will be necessary. The laboratory tests should also include a determination of the coefficient of permeability according to methods developed by Dr. Charles Terzaghi (*Engineering News-Record*, Nov. 19, 1925, p. 832).

Designs of the Drainage System

Artificial drainage may serve (1) to remove surface water, (2) to intercept seepage and (3) to reduce the extent of heaving of runways due to frost action.

To remove surface water, drains should be placed along the edges of runways, and when runways are not used, drains should be spaced in the entire landing area at distances depending upon the volume of water to be removed, the slope of the field and the resistance of the surface of the field to erosion.

To intercept seepage, drains again should be placed along the edges of runways and, depending upon conditions discussed subsequently, drains should be placed also beneath the runways. When no runways are used, the spacing of drains in the landing field presents a

complex problem for which no accurate solution is at present available.

In the absence of other means, a test for the coefficient of permeability performed on undisturbed soil, as proposed by Dr. Terzaghi, furnishes the most promising means for estimating the spacing of drains in airports. Direct field observations to supplement the laboratory determination also may prove helpful. A knowledge of this coefficient furnishes an indication of the amount of surface water to be disposed of (runoff factor) and of the rate at which groundwater is apt to enter the drains. According to various studies it has been shown (1) that the velocity of percolation varies directly with the distance between laterals and (2) that the velocity varies approximately with the depth of the drains.

Artificial drainage will remove only gravitation water

FIG. 2—CONSTRUCTING A TAR PENETRATION SURFACE AT BETTIS FIELD, PA.
This field which is now under construction consists of a base course of rolled slag and a 3-in. top course of tar-penetration slag macadam.

or that portion of the total moisture content of the soil which moves under the influence of gravity. Water which rises in the soil due to surface tension or capillarity cannot be removed by this means.

A final fact to be remembered is that water cannot enter soil containing air until after the air escapes. This air must escape through the drain and it is obvious that the closer the drains are spaced the greater is the percentage of precipitated water which is apt to enter the ground surface and enter the drains via percolation.

Frost Heaves—To reduce the extent of detrimental heaving of runways, drains should be placed beneath them. According to several authorities, drains backfilled with gravel and placed longitudinally under the center of gravel road surfaces are effective for curing frost boils in Minnesota and Wisconsin. Drains either located along the edges of road surfaces or laid herringbone, in contrast, have not proved effective for serving this purpose. This may be explained by the fact that heaving is caused by the formation of well-defined ice layers in the soil instead of by simple expansion of water due to freezing.

In sands no important frost heave occurs, because practically all of the contained water freezes at normal freezing temperatures and the small unfrozen water particles do not exist in amount sufficient to increase appreciably the size of the frozen particles.

Permeable silts (Groups A-4 and A-5) are apt to suffer extensive frost heave. The capillary rise in cohesive clays also may be as high as in silts. However, the speed with which water rises in clays is much less than in silts, so that in dense clay soils (Group A-6) with low groundwater level and absence of lateral seepage, only limited amounts of water are available for ice segregation.

Frost depth under runways is apt to be greater than under the shoulders. Accordingly, a center drain will serve (1) to lower the moisture content of the soil before freezing, and (2) to provide for the disposal of water liberated by thaws.

Rules for Runway Drainage

Recommendations for draining runways are:

With low groundwater level, no drainage seems necessary in the porous varieties of Group A-2 and A-3 subgrades. Drainage to remove surface water in Groups A-1, A-4, A-5, A-6 and A-7 subgrades is necessary. In addition, drains to reduce the moisture content of the soil prior to freezing and to carry away the water liberated during thaws should be placed under runways resting upon porous Group A-4, all Group A-5 and porous flocculated clays of the Group A-7 variety. Also drains should be employed to lower high groundwater level when existing in all soils.

Especially important with respect to frost heave are soils consisting of sand to a depth of as much as 12 or

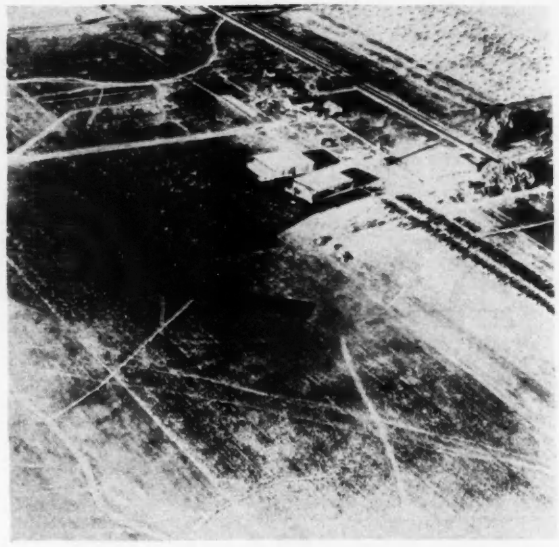


FIG. 3—TAR RETREAD RUNWAYS AT DAYTON, OHIO

18 in. underlain with silt zone (Group B-1 subgrade) which sags and permits water to accumulate. Proper remedy may consist in excavating the subgrade to a depth slightly greater than the depth of frost penetration, coating the soil with bitumen material and backfilling with a good A-3 material.

Field Drainage Suggestions

When the groundwater elevation is very low and an impervious top soil (dense varieties of both Groups A-4 and A-6 subgrades) is underlain with a porous soil zone, only properly backfilled trenches are required to dispose of surface water by draining it into the porous understratum of soil.

When the landing field consists of a dense impervious clay (Group A-6 variety), the runoff factor will be high and the spacing of drains therefore depends both upon the slope of the field and the resistance of the soil to erosion.

When the soil profile consists of porous silt (Group A-5) to a depth of 3 or 4 ft., underlain with a dense impervious clay (Group A-6), a condition exists similar to that productive of frost boils.

The Group B-1 subgrade furnishes a radical case in which the drains must serve to remove the surface and the groundwater as quickly as possible and is complicated by the fact that silt top soil is apt to erode quickly. Consequently drains may need to be spaced as closely as 30 or 33 ft. apart.

Instead of attempting to drain soft peat and muck soils (Group A-8), cover them with a layer of good material at least 3 ft. thick in locations where frost does not

FIG. 4—GRAND CENTRAL AIRPORT, GLENDALE, CALIF.
Concrete runway and 300x1,500-ft. landing strip with a mixed-in-place surface 6 to 7 in. deep. The application consisted of 3.2 gal. of 60-70 per cent asphalt per square yard.

occur and about 4 ft. thick where frost is apt to occur to an appreciable extent. Mucks will probably serve airport purposes better when wet and covered than when dry and uncovered.

Depth of Drains—Generally, drains should extend to an impervious subsoil zone, when one exists within 3 ft. of the top of the ground where freezing is absent and when one exists within 4 ft. of the top of the ground where freezing in appreciable amount is apt to occur.

When no impervious under zone exists, extend drains to a depth of about 3½ ft. in clays and 5 ft. in silts where freezing does not occur. Otherwise drains should extend to a depth equal to at least the depth of frost penetration.

Size of Drains—The size of drains depends upon the quantity of surface water to be removed, which in turn depends upon the rate of rainfall, the size of the area to be drained, the surface runoff factor and the time allowed for the removal of the water. Surface runoff factors may be assumed to be approximately as follows: watertight runway surfaces (asphalt runways in good order), about 90 per cent; concrete runways with well-maintained joints and cracks, about 80 per cent; oiled runways, about 70 per cent; untreated macadam runways, about 40 per cent; undrained turf, about 20 per cent; well-drained turf, about 5 per cent.

A period of three hours from the beginning of the storm has been suggested for removing the runoff from an average maximum hourly rainfall exceeded but once a year.

U. S. Department of Agriculture Bulletin 854, "The Flow of Water in Drain Tile," by D. L. Yarnell and Sherman M. Woodward, contains charts which furnish a convenient and accurate means for determining the size of drain tile.

Backfilling Drains—Engineers seem to agree that trenches containing airport drains should be backfilled with porous materials. This porous material for trenches located in cohesive soils (Groups A-6 and A-7), which are not apt to flow when wet, may consist of gravels, crushed stone, slag, etc. For trenches located in cohesionless silts, which are apt to flow when wet (Groups A-4 and A-5 material), sand may serve as an efficient backfill material. The top 6 or 8 in. of the fill should possess a stability necessary to support the airplane wheels. This might be furnished either by a sand containing a small amount of clay or crushed angular rock fragments 2 to 3 in. in size.

Finally, it must be kept in mind that an airport drainage system is primarily a storm sewer system and therefore should include the construction of manholes or other appurtenances necessary to permit either examination of or the cleaning out of drains.

* * *

Airport Surfaces

By C. N. Conner
Engineer Executive, American Road Builders' Association

During the past two years only have airports been extensively surfaced with materials other than earth or sod, and these surfaces have been highway types. A discussion of any type of surfacing must consider three

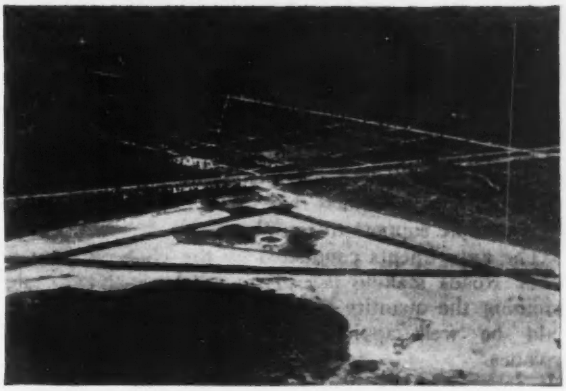


FIG. 5—TWO SHELL AND CINDER RUNWAYS AT JACKSONVILLE, FLA., MUNICIPAL AIRPORT
Shell base 6 in. thick treated with ¾ gal. of asphalt and topped with a 2-in. cinder surface treated with ¾ gal. of asphalt per square yard. Taxiway and apron consists of 8 in. of soil mixed in place with 2 ga.. of asphalt per square yard.

principal factors: (1) the load, (2) the structure—that is, the surfacing—(3) the foundation—that is, the subgrade on which the surfacing is laid. The first two factors will be discussed in this paper.

Airport Loading

There appears to be a lack of agreement on the amount of impact delivered by a plane in landing. Impact may be reduced by (1) equipping planes with shock-absorbing devices, (2) low landing speeds, (3) small gliding angle of approach and (4) rubber-tired wheels in place of tail skids. Many impact experiments have been conducted by the U. S. Bureau of Public Roads under the direction of A. T. Goldbeck, who offers the following comments:

FIG. 6—CINDERS 4 IN. DEEP PENETRATED WITH CUT-BACK ASPHALT AT NEWARK, N. J.
Note slight markings of tail skids.

"Impact action of an airplane in landing is closely analogous to that of the automobile striking a road surface after it has rolled over a rough spot in the road. The force exerted on an airplane runway is due not only to the unsprung weight (as in the case of the automobile) but to the sprung weight, and it becomes necessary therefore to introduce into the highway impact force formula $F = Ma$ a factor to take care of the pressure exerted by the sprung weight of the plane. The formula would then be $F = Ma + wd$, in which M equals the mass of the unsprung portion of the plane, a equals deceleration at any instant of that unsprung portion, w equals force required to stretch the springs of the plane and d equals the amount of that stretch in inches at any instant.

"It would seem that in the above formula for impact the quantity wd will be practically unaffected by the type of landing surface and that a will also be practically unaffected. It is difficult for me to believe that there can be any great amount of difference in impact exerted by planes in landing depending upon the type of surfacing material, provided that surface is so designed as to give ample support to the plane.

"The experiments conducted by the U. S. Bureau of Public Roads making use of an accelerometer for determining the quantity a for use in the above formula could be well applied to similar experiments on airplanes."

It is evident from the foregoing that research is needed to determine the loads for which airport surfaces are to be designed.

Airport surfaces should be classified into four major groups: (1) graded and drained (earth and sod), (2) low types, (3) intermediate types, (4) high types.

Graded and Drained

All airports must be graded and drained whether or not they are to receive a subsequent surface. Gradients should vary from ½ to 2 per cent. The principal advantage of an earth surface is low first cost, while its disadvantages may be listed as follows: Its maintenance cost is high, it is dusty when dry, it is muddy when wet, it is irregular and bumpy to motors, and bearings of planes are damaged by dust. The advantages of turf surfaces are: Its first cost is low, it is resilient, it has a fair surface for wheel braking and it has minimum glare at night, and its disadvantages are: Its maintenance cost is high, it offers poor visibility, it has a poor background for marking, it is damaged by tail skids and wheels, considerable time is required to establish turf and it is not suitable for heavier planes.

Low-Type Surfaces

Low-type surfaces include selected soils, sand-clay, gravel, crushed stone, slag and cinders. Automobile tractive resistance is about 70 lb. per ton. Dust on such surfaces may be greatly reduced by the use of dust preventives, but the claim is made that the chemicals in some of these seriously damage planes which have metal bodies. (It was brought out in discussion that calcium chloride had been prohibited for use at the Akron municipal airport because of the Goodyear-Zeppelin Corporation's claim that tests showed it damaged the duralumin used in its airships.) The advantages of low-cost surfaces are: The first cost is low, stone, slag, gravel and sand-clay have good visibility, they have good drainage, they are good for wheel braking and they offer a good base for future surfaces. The disadvantages are: The maintenance cost is high, cinders have poor visibility, they have a poor background for markings, they are damaged by wheel and tail skids, they are dusty when dry and flying particles damage fabric, motors and propellers.

For an average thickness of 5 or 6 in. the surfaces should cost from 20 to 80c. per square yard. The cost will depend largely on the availability of local materials and the cost of their preparation.

Intermediate Types

Included in this grade are bituminous surfaces of various types and thickness which are laid on a prepared subgrade or base course other than concrete.

FIG. 7—TWO VIEWS OF NEW CURTISS AIRPORT AT VALLEY STREAM, L. I., SHOWING 600-FT. SQUARE LANDING AND TAKE-OFF AREA

Above—Constructing the surface using 3⅜ gal. of 80 per cent asphalt per square yard mixed in place with natural soil. Cost, 70c. per square yard. Below—The completed surface.

There are four general types: (1) surface treatment, (2) penetration macadam, (3) mixed-in-place, (4) premixed. The automobile tractive resistance of all of these types is approximately 110 lb. per ton.

Surface Treatment Type—The application of bituminous materials on a surface of less than ¼ in. has not been generally satisfactory on earth roads or airports. They lay the dust but are too thin and fragile for service. When heavier bitumens are used with selected aggregate for cover, this method will give reasonably good results provided the base is firm and unyielding. This type has the following advantages: The first cost is low, it is resilient, it is good for wheel braking and permits rapid construction. Its disadvantages are: Maintenance cost is high, it offers poor visibility without white markings,

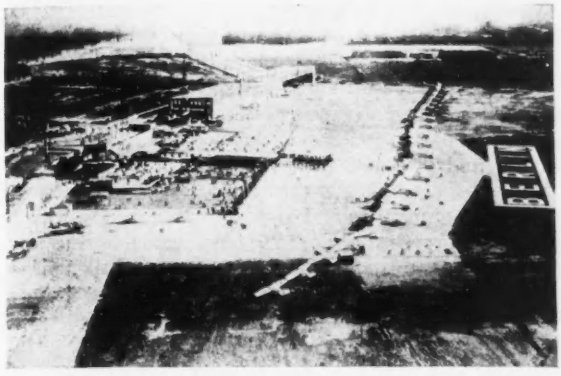


FIG. 8—TEMPELHOF AIRPORT, BERLIN, GERMANY

it is damaged by tail skids, there is likelihood of damage to planes from loose material on surface, and there is serious damage by frost without good base and subdrainage.

The cost of the base courses may vary, as already stated, from 20 to 80c. per square yard. The first cost (initial construction) of the surface course should vary from 10 to 30c. per square yard.

Penetration Macadam—Bituminous penetration macadams are usually laid on substantial base courses of crushed stone or slag and less frequently on gravel. The surface consists of broken stone or slag whose particles are bonded together by asphalt or tar, while the immediate top is further treated and waterproofed by a seal coat of chips and bitumen. The finished surfacing is commonly from 2½ to 3 in. thick, exclusive of the base. Their advantages are: They have fairly long life, construction cost is moderate, maintenance cost is moderate, they offer a good surface for wheel braking, the surface is tough, construction plant setup is inexpensive and they are mudless and dustless. Their disadvantages are: Skilled construction is needed, white marking for good visibility is necessary and skilled maintenance must be provided for.

The costs for a bituminous macadam 2½ or 3 in. in thickness vary from about $0.80 to $1.30 per square yard.

The Mixed-in-Place Type—This type is particularly adapted for improving low-type surfaces which are loosely bound and otherwise unstable, such as sand-clays, cinders, slag, gravel and stone. Good surfaces of from 1 to 6 in. in depth may be built up by mixing bitumen in place on the field with these aggregates or by adding new aggregates with which bitumen is mixed. In highway work, traffic assists in compacting the surface, but this important factor is lacking for airports. Surfaces which are 2 in. or more in thickness are desirable. Durable, angular aggregates are preferred. Bitumens which are not seriously affected by heat or cold and which make mixtures not easily displaced under traffic give good results. The advantages of this type are: Its first cost is moderate, its maintenance cost is moderate, it is mudless and dustless, construction plant setup is inexpensive, it offers a good braking and smooth riding surface and it has a fairly long life. Its disadvantages are: White marking for good visibility is necessary and skilled maintenance must be had.

The Premixed Type—These types are composed of aggregates and bitumens and may or may not contain a filler of very fine material. They are commonly mixed in a pug mill, hauled to the construction site, spread and rolled. The amount of bitumen used ranges from 3 or 5 per cent for the coarser mixtures to 10 or 12 per cent for the finest mixtures. Aggregates range all the way from a fairly coarse stone in some types to the finest sand in others. All of these premixed types should be laid on suitable bases which have regular surfaces. The mixtures which are laid hot include standard surfaces of sheet asphalt with a binder course, bituminous concrete, black base and mixed macadam. The mixtures which are laid at atmospheric or slightly higher temperatures are generally known by trade names. The advantages of this type are: It has longer life than mixed-in-place types, maintenance cost is lower than that of mixed-in-

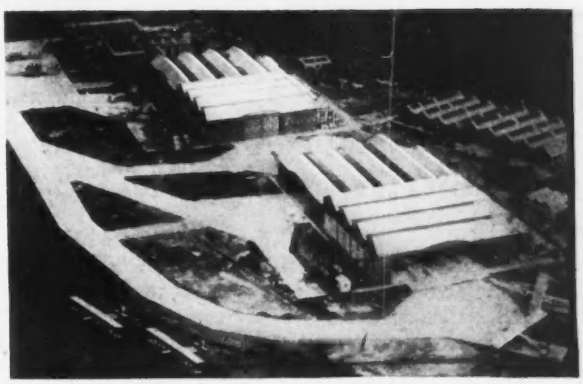


FIG. 9—CONCRETE DRIVES AND TAXIWAYS, CROYDON AIRPORT, NEAR LONDON, ENGLAND

place types, it has a rougher type surface good for wheel braking, it is mudless and dustless and it is tough and durable. The disadvantages are: Skilled construction is necessary, first cost is fairly high and white marking for good visibility is necessary.

Surfaces of the premixed type are commonly laid 2 in. in thickness. For these the cost will range from $0.80 to $1.40 per square yard, and where local materials are available, the cost is near the lower limits.

High-Type Surfaces

The principal high-type surfaces are: (1) plain portland cement concrete, (2) reinforced portland cement concrete, (3) portland cement concrete base with a wearing course of bituminous concrete or sheet asphalt, (4) portland cement concrete base with a wearing course of brick or stone blocks. The automobile tractive resistance of these types is 70 lb. per ton.

Plain Portland Cement Concrete—The advantages of this type are: Maintenance cost is low, it offers good visibility, it has long life, it is mudless and dustless, it is

good for wheel braking, and it is tough and durable. Against these are such disadvantages as the need for skill in design and construction and a fairly high first cost. Plain portland cement concrete 5 or 6 in. in thickness should be laid at a cost of $1.70 to $2.50 per square yard.

Reinforced Portland Cement Concrete—Reinforced-concrete roadways, according to comprehensive surveys, are showing less deterioration than plain concrete, resulting in lower maintenance cost and longer life. Other advantages or disadvantages are the same as for plain concrete.

Bituminous Concrete and Sheet Asphalt—This type includes the fine-graded aggregate types, the coarse-graded aggregate types and binder with surface course of sheet asphalt. All of them are hot mixes and have been previously described under premixed bituminous types. In this instance they are laid on concrete base instead of broken stone or black bases. Their advantages are: Maintenance cost is low, they have long life, they are mudless and dustless, they are good for wheel braking and they are tough and durable. Their disadvantages are: Skill for design and construction is needed, first cost is high and white markings for good visibility are necessary.

Bituminous pavement types of surfacing 2 in. in thickness on a portland cement concrete base 5 in. in thickness will cost from $2.50 to $3 per square yard.

Brick and Block Surfaces—Brick is less expensive than stone block, and wood block generally is not a satisfactory surfacing for pavements. Best present practice in highways calls for a sand cushion on the base course; on this the brick are laid and the open joints filled with bitumen. The advantages of this type are: Maintenance cost is lowest, it has long life, it is mudless and dustless, it is good for wheel braking, it is tough and durable and it offers good visibility. Its disadvantage is its high first cost.

Brick surfaces on portland cement concrete base will cost from $2.50 to $3.50. If lower-type bases are used, the cost may be reduced, but the brick surfacing itself will range from $1.25 to $1.75 per square yard.

Conclusions

(1) Research is needed for determining the landing force imparted to airport surfaces by aircraft. (2) Surfaces of earth and turf are inadequate for heavy planes. (3) Traffic surveys and intelligent planning are necessary before determining on the method of procedure and type of surfacing. (4) Construction and maintenance methods for airport surfacing are the same as for highway surfacing. (5) In general the high types of surfacing cost the most for initial construction. (6) The high types of surfacing cost less for maintenance than the low and intermediate types. (7) The visibility of types is not discussed in this paper. It is a subject for experts in aeronautics and airport lighting. (8) Strong indications are that airport surfaces when of the same type as highway surfaces should cost less than highway surfaces, because they may be thinner and because construction conditions are more easily controlled. (9) Highway engineers, highway contractors and highway equipment manufacturers are the best qualified group for constructing and maintaining airport surfaces.

Santa Fe Uses Large Proportion of Treated Track Ties

TO WHAT a great extent the use of treated ties has been carried by the Atchison, Topeka & Santa Fe Railway is shown by the following abstract of a paper by R. S. Belcher, manager of treating plants, at the recent annual meeting of the Roadmasters and Maintenance-of-Way Association. The experience with different preservatives and the relation of spikes and tie-plates to tie-treating economy are also noted.

The Santa Fe has been treating crossties for 44 years, and to date 90,000,000 ties have been treated. Of the ties inserted in 1928, 99 per cent were treated, and we estimate that 94 per cent of all the ties are treated, the remainder being largely redwood. The general decrease in our tie renewals per mile of track during the past 30 years is evidence of the value of preservative treatment.

In general, the railways are spending more than formerly for the conditioning of their ties before treatment. A greater effort is being made to get the ties out of the woods without delay and into the treating plants, where seasoning can be done more satisfactorily than elsewhere. Machine adzing for the tieplates and boring of spike holes prior to treatment is standard practice on many roads and is increasing steadily. Of the 74,000,000 ties treated in the United States in 1927, 28.79 per cent were adzed and bored, 6.14 per cent were bored only and 5.22 per cent were adzed only.

While some ties that have failed show several kinds of failure in the same tie, we have classified them for failure under the following heads: decay, spike, killed, shattered, rail cut, plate cut, derailment, split, broken and burned. Decay, spike killing and shattering account for most of the ties taken out of our tracks in the past ten years, as shown by the accompanying table. We use a great many pine and fir ties, and both of these shatter badly under certain conditions, but the addition of petroleum residuum, or fuel oil, to either the creosote or the zinc chloride treatment will help prevent shattering. As a result of experiments starting in 1909, the creosote-petroleum mixture treatment was made standard on the Santa Fe in 1923. This treatment, together with the careful distribution of ties of the various woods to those parts of the system where each will give best results, will do much to overcome shattering. Altogether 15,791,147 crossties, or approximately 21 per cent of the ties treated in the United States in 1927, were treated with a creosote-petroleum mixture, fifteen railways using this preservative.

CAUSES OF TIE REMOVALS IN TEN YEARS; SANTA FE RAILWAY

Ties	Decay, Per Cent	Spike Killed, Per Cent	Shattered, Per Cent	Others, Per Cent
Creosoted	0.5	49.5	44.0	6.0
Zinc-creosote	60.0	8.0	30.5	1.5
Untreated	80.0	7.0	7.5	5.5

Spike-killed ties were, in general, ties which had not been prebored for the spikes. We are now preboring and pre-adzing all ties before treatment. When the spike is driven into the treated prebored hole, a big step has been taken toward protecting the tie from the crushing of the wood fiber and decay around the spike, so far as the first spike is concerned. But what of the numerous other spikings incident to rail laying, regaging track and spacing ties? Ordinarily, prebored ties should have four holes bored at each end of the tie. This will permit reversing the spiking at some time during the life of the tie. In treating ties with bored holes, additional preservative goes where it will do the most good, at the rail base. All unnecessary spiking should be eliminated and the necessary spiking should be carried out with greater care than is usually the case. To obtain the advantages of preboring, the holes in the tie plate must be lined up with the holes in the tie.

There has been much improvement in tie-plate design, for in former years many ties were taken out of track because of rail cutting or the damage done by small or poorly designed tie plates. When respiking, it is important that a well-made tie plug be used to fill the old spike hole. In track work it is often necessary to adze treated ties for tie plates, gaging to eliminate wheel marks and for other reasons. Swabbing the adzed surface with a hot preservative composed of 50 per cent creosote and 50 per cent petroleum residuum, creosote-coal tar solution or straight creosote is well worth the trouble and expense of the application and of keeping the preservative hot. Several different types of heaters have been developed which are convenient for track use.

ORIENTAL IMPRESSIONS--

World Engineering Congress at Tokyo

By Kendall K. Hoyt
Staff Correspondent, Engineering News-Record

Tokyo, Nov. 7, 1929.

TODAY, when the World Engineering Congress is closing here, its remarkable value as a means for bringing together technical men from all the world's countries is freely acknowledged by the departing delegates. Whatever doubts of success may have arisen during the initial rush and confusion rapidly faded as soon as the program began to operate. For the overseas members the event was a social success, and it was a technical success for those few who were minded to attend the sectional sessions.

Free exchange of ideas by both of these means of contact—the visitors learning about Japan and the Japanese receiving the advice and good will of some of the most prominent men in the engineering practice of other countries—has made the meeting no small step in the development of Japanese industry and the improvement of world relations.

Though the actual sessions have drawn to a close, hundreds of the foreign visitors will be some weeks yet on conducted tours through Japan, Formosa and Korea. It will be well into January before most of the American delegates have returned. The side trips so far have been scenic: to the famed temples of Nikko and the Hakone district with its lakes, hot springs and views of Fuji. The latter have been enhanced by unusually clear weather for most of the parties. In fact, by an unusual circumstance, the official boats docked in Yokohama with the great mountain in full view, a most auspicious welcome. But except for the cities of Tokyo and Yokohama, most of the delegates have not yet seen Japanese industrial regions. That is still to come. Getting down to industrial matters will not be an easy transition, but when sandwiched in with more scenery plus maple blossoms and objects of art, these tours of Japanese factories and power plants are not likely to prove tedious.

During the Congress Week

Looking back over the past week, one recalls a rapid series of dinners, balls and garden parties, each one, it seemed, more brilliant than the last. With their characteristic hospitality the Japanese have turned things inside out in their eagerness to please and have shattered established traditions in the freedom and entrée which they have permitted. Foreign residents in Tokyo say that the Congress people are seeing more of Japan in two weeks than others would see in as many years, along with some things that most visitors never see. Houses and grounds of the royal family, of the aristocracy and of the wealthy Japanese have been thrown open for the larger events and private homes to the individual delegates.

It is a truism that most of the real business of conferences such as this is transacted at the social rather than at the business functions. The people here have been given ample opportunity to mingle outside the formal atmosphere of the prepared discussions, to exchange ideas and to learn at first hand what is being done in their line in South Africa, or China, or Hawaii; and also to attain some conception of the progress in countries whose place in the scheme of things is likely to be half forgotten until called to mind. The visiting engineers were reminded of long-forgotten dignities by frock coats and high hats, together with more than an occasional cane and white gloves. One had opportunity to learn new words and customs, and to relearn when and how potable beverages are to be taken.

In order to give due credit to the man who, above all others, was responsible for the success of the conference, Baron Koi Furuichi, who is president of the engineering and power meetings, was given an honorary membership in the American Society of Civil Engineers. Dr. C. E. Grunsky, past-president of the society, made the presentation speech.

World Federation of Engineers Advocated

At the instance of Dr. Stan. Spaeck, of the Czechoslovakian delegation, a resolution was offered advocating the creation of a world federation of engineers. This movement has received strong support in Germany and other European countries. Presumably the matter will have reached a more tangible form at the next meeting of the World Engineering Conference, which has tentatively been set for Chicago in 1933.

Turning to the strictly technical side of the Congress, much can be inferred from the nature of the book of technical abstracts without turning the leaves. The book is printed on thin paper, one abstract on each page. This book is 2½ in. thick and weighs 3 lb.! Such a ponderous tome was enough to frighten off all but the most studious. After the first day the attendance remained, shall I say gratifying?—but the sessions were peopled almost exclusively by Japanese.

Encyclopedic Technical Papers

Without reflection on the Congress preparations, which are recognized as equal to or better than any prior ones, it ought to be pointed out that everyone recognizes the trend of technical discussions at international engineering meetings to be approaching absolute futility. Everyone knows it, but no one does anything about it. Veteran delegates simply stay away from the conference rooms except when some paper of specialized interest is up for discussion. Many of the visiting engineers are among the leading minds in their various branches; it really seems as though some better use of their time could be devised than to conduct these heavy and empty sectional sessions.

Of the typical papers many are of purely encyclopedic type; doubtless much of their contents can be found in texts and reference works, in fact, while the rest probably has been told by the technical press or else is suitable matter for publication in the transactions of one of the engineering societies. Perhaps one good rule for the future would be to require that at least 10 per cent of every world congress paper must relate to the future of the subject in question.

International events strongly suggest the need for a universal language. Due to the prevalence of English in the Orient, less difficulty is encountered here than is met with in some other countries. There was talk of standardization of units to the metric system, but this very argument, presented (as it was) in various accents, showed that some simpler means of conveying idea is the most urgently needed standardization.

Power-Shovel Production Grading Highway Roadbed

Shovel Performance in Different Materials From Sandy Loam to Blasted Rock for Over 400,000 Cu.Yd. of Grading

By Andrew P. Anderson

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UNDER present field conditions and methods of power-shovel operation, poor or indifferent blasting of such materials as solid rock, hard shale and tough hardpan invariably results in a marked decrease in the rate of production. Poor grubbing and clearing of ground which is otherwise adapted to fast operation is another large and far more frequent cause of low rate of production. Work in very sticky or adhesive materials also shows a slow rate of operation. On the other hand, the average rate of production in really well-blasted rock is practically as great as that secured in ordinary common excavation.

These conclusions are based on a study of the actual average rates at which power shovels were found to be operating and at which pay yardage was being handled on more than 120 going projects in various sections of the United States. This study includes an analysis of 48,000 complete shovel cycles and a compilation of records giving complete data on the movement of more than 400,000 cu.yd. of excavation.

In compiling the final tables, all jobs on which the mechanical condition of the shovel was rated below fair have been entirely omitted. It may be mentioned in passing, however, that a brief separate examination of a considerable number of jobs on which the mechanical condition of the shovels was rated as poor indicates that the effect of such condition was to increase the operating cycle an average of approximately 14 per cent and to increase the amount of time lost from major delays by approximately 26 per cent above the averages found for the jobs on which the mechanical condition of the shovels was rated as fair or better. No attempt has been made in this study to divide the jobs according to grade of management or rate of operation, but with the above-mentioned exclusion of all jobs on which shovels in poor mechanical condition were being used, all grades of job management have been included.

In order to afford a ready means of comparison, the more important features of this study have been summarized in Tables I and II. In every case the number of cycles or the quantities on which the given averages are based are shown in order that the proper weight may be given to each result in making any further comparisons. In most cases, however, it is believed that the basic data are sufficient to give fairly representative values for the average operating methods as they now exist and may therefore be accepted as a rough index of the relative effect on rates of operation and production which may reasonably be expected in changing from operations on one class or kind of material to operations on another.

Special attention is called to the fact that these data are average values obtained from the grouping of a large number of jobs on all of which the shovel was in good or at least fair condition but which were managed with varying degrees of efficiency. They present, therefore, not a record of the rate at which a shovel in good mechanical condition should and frequently does operate but rather an indication of the rate at which jobs chosen purely at random may be expected to be operating. The rate at which the power shovel can be operated and the many factors which affect both the rate of its operation and the rate of its actual production are fully discussed in a series of three articles entitled "Power-Shovel Operation in Highway Grading," in *Public Roads* of February, March and April, 1928, and to which this article is merely supplemental in that it extends very greatly the data tending to show what effect the material has on the rate of operation and production.

TABLE I—EFFECT OF KIND AND CHARACTER OF MATERIAL ON RATE OF SHOVEL PRODUCTION
(Average time in seconds required for each operation as obtained from analysis of 48,000 cycles.)

Size of Shovel Dipper in Cu.Yd. (1)	Kind of Material (2)	Load (3)	Swing (4)	Dump (5)	Return (6)	Total Cycle (7)	Angle of Swing	No. of Cycles Analyzed	Average Cut, Ft.	Possible Dipper Loads per Hour*
All sizes	All material	10.45	5.89	3.36	6.06	25.76	107	47,920	8.5	140
¾ and ⅞	All material	10.52	5.83	3.41	5.96	25.75	110	26,982	9.3	140
1 and 1¼	All material	10.5	5.9	3.3	6.2	25.90	100	15,025	8.5	139
1½ and 1½	All material	9.7	6.0	3.3	6.2	25.3	112	5,913	7.2	142
All sizes	Common, all kinds	9.59	5.87	3.31	6.03	24.80	102	31,569	7.5	145
All sizes	Shale, all kinds	10.6	6.4	3.0	6.2	26.2	115	2,301	8.0	137
All sizes	Rock, all kinds	12.34	5.85	3.53	6.10	27.82	118	14,050	11.4	129
¾ and ⅞	Good common	8.2	5.7	2.8	5.9	22.6	112	5,513	8.5	159
1 and 1¼	Good common	7.5	5.2	2.6	5.5	20.8	75	1,564	7.2	173
1½ and 1½	Good common	7.0	5.7	2.0	6.2	20.9	100	892	12.0	172
All sizes	Good common	7.9	5.6	2.7	5.8	22.0	105	7,969	8.5	164
¾ and ⅞	Wet and sticky clay	10.3	5.8	5.0	6.2	27.3	110	1,850	5.7	132
1 and 1¼	Wet and sticky clay	9.4	6.2	5.4	6.7	27.8	110	1,366	7.0	129
1½ and 1½	Wet and sticky clay	9.4	6.4	5.2	6.4	27.4	115	1,223	7.4	131
All sizes	Wet and sticky clay	9.8	6.1	5.2	6.4	27.5	112	4,439	6.0	131
¾ and ⅞	Rock, well blasted	9.7	5.2	2.5	5.8	23.2	110	2,239	12.0	155
1 and 1¼	Rock, well blasted	9.6	5.9	2.7	6.5	24.8	112	2,158	20.0	145
1½ and 1½	Rock, well blasted	9.2	6.0	2.4	6.5	24.0	115	44	4.0	150
All sizes	Rock, well blasted	9.6	5.5	2.6	6.1	23.8	113	4,441	13.8	151
¾ and ⅞	Rock, poorly blasted	16.1	6.2	5.8	6.3	34.4	148	2,841	12.5	105
1 and 1¼	Rock, poorly blasted	15.4	7.1	4.2	7.2	33.9	130	1,150	11.0	106
1½ and 1½	Rock, poorly blasted	15.3	7.4	3.7	7.2	33.6	160	265	5.0	107
All sizes	Rock, poorly blasted	15.9	6.5	5.1	6.5	34.0	141	4,256	11.7	106
¾ and ⅞	Clay, hard or tough	8.9	6.4	2.6	7.3	25.2	115	510	7.0	143
1 and 1¼	Clay, hard or tough	9.7	6.3	3.9	6.6	26.6	107	1,142	5.5	135
1½ and 1½	Clay, hard or tough	8.9	6.3	3.5	6.7	25.4	130	596	5.4	141
All sizes	Clay, hard or tough	9.4	6.4	3.5	6.7	26.0	115	2,248	5.8	138
¾ and ⅞	Common with rocks and roots	10.3	5.7	3.3	5.8	25.0	95	4,641	7.6	144
1 and 1¼	Common with rocks and roots	10.2	5.2	2.5	5.8	23.7	80	2,247	6.1	152
1½ and 1½	Common with rocks and roots	10.3	5.6	2.7	5.8	24.5	110	1,037	6.6	147
All sizes	Common with rocks and roots	10.3	5.6	3.0	5.8	24.7	92	7,925	7.2	146

*Based on total cycle as given in column 7.

TABLE II—EFFECT OF KIND AND CHARACTER OF MATERIAL ON POWER-SHOVEL PRODUCTION IN HIGHWAY GRADING WORK
(Only shovels rating from fair to good as to mechanical condition included in obtaining these data.)

Kind of Material	Size of Shovel, Cu.Yd.	Job Records			Actual Rate of Operation as Determined From Stop-Watch Studies					
		Total Hours Crew Out on Job	Total Yardage Moved, Cu.Yd.	Average Cu.Yd. Per Hour Crew on Job	Total Time of Studies, Minutes	Total Dipper Loads Moved	Average Dipper Loads Per Hour	Per Cent of Total Time Shovel Actually Digging	Possible Dippers Per Hour*	Cu.Yd. Per Dipper Load†
All materials usually classed as common excavation	¾ and ⅞	1,476.72	57,968	39.3	18,464.61	28,099	91.3	59.6	153	0.430
	1 and 1⅛	2,334.88	138,239	59.2	29,947.73	43,987	88.1	53.4	165	0.672
	1¼ and 1⅜	799.68	47,997	60.0	13,416.88	19,674	88.0	62.0	142	0.682
Good to fair common, easy digging, no boulders or sticky materials	¾ and ⅞	1,042.55	41,654	40.0	12,049.96	18,361	92.0	59.7	154	0.436
	1 and 1⅛	1,622.77	93,125	57.5	19,805.17	28,671	87.0	59.0	147	0.662
	1¼ and 1⅜	700.96	44,642	63.8	7,345.66	10,743	87.7	59.0	149	0.730
Loam and clay, containing considerable roots or stones, few too large for easy handling	¾ and ⅞	684.18	24,362	35.6	6,901.76	10,589	92.0	61.8	149	0.387
	1 and 1⅛	1,125.17	58,830	52.3	12,399.58	17,378	84.2	59.4	142	0.622
	1¼ and 1⅜	489.22	24,735	50.6	4,120.02	5,365	78.1	57.2	137	0.648
Clay, some hard and tough, but none sticky, mostly fair digging	¾ and ⅞	296.42	14,894	50.4	3,809.99	5,955	94.0	59.7	158	0.537
	1 and 1⅛	417.18	29,075	69.6	4,708.44	6,845	87.5	58.5	150	0.796
	1¼ and 1⅜	60.60	3,196	‡52.7	1,898.00	2,462	78.0	56.9	137	‡0.677
Loamy and sandy material which digs easily and dumps clean	¾ and ⅞	61.95	2,398	38.7	1,338.21	1,817	81.6	47.9	170	0.474
	1 and 1⅛	80.42	5,220	65.0	2,697.15	4,448	98.7	58.1	170	0.659
	1¼ and 1⅜	151.14	16,711	110.0	1,327.64	2,916	132.0	68.0	196	0.834
Rock, well blasted, very few pieces too large for dipper, no digging from solid	¾ and ⅞	112.31	4,671	41.6	6,378.92	11,091	104.0	65.5	158	0.400
	1 and 1⅛	856.29	48,293	56.4	7,835.53	12,103	92.7	62.9	147	0.607
	1¼ and 1⅜	20.00	1,394	69.7	892.00	1,301	87.6	57.4	152	0.794
Rock, poorly blasted, many pieces too large to enter dipper freely, difficult digging	¾ and ⅞	523.97	15,325	29.2	6,417.18	7,850	73.3	62.4	117	0.398
	1 and 1⅛	241.55	10,699	44.3	3,211.00	3,860	72.1	62.5	115	0.613
	1¼ and 1⅜	262.67	9,185	§35.0	1,085.65	1,003	55.4	58.7	81	0.631

*The number of dipper loads which could have been moved per hour at the observed rate of operation if all time losses had been eliminated.
†Average amount of material, measured in place in cut, moved each dipper load.
‡Operator on this job was slow and careless.
§Includes data from two jobs on which the blasting was unusually poor. Very difficult digging.

Table I shows what effect the material has on the several parts of the operating cycle. The shovels have been grouped in three classes in accordance with the size of the dippers in order to bring out what variations if any might be due to the size of the shovel. No material difference is indicated by any particular size group, except possibly in poorly blasted rock, where the smaller shovels seem to be somewhat slower both as to loading and dumping the dipper. The last column in Table I shows the number of dipper loads which could be handled per hour at the corresponding operating cycle, providing no stops or delays of any kind were permitted. Perfect operation, however, is very seldom attained. Ordinarily from 35 to 45 per cent of the total working time when the crew is on the job is lost in numerous minor delays, each of less than fifteen minutes' duration.

Table II is a compilation of the production data and stop-watch studies obtained during the movement of approximately 350,000 cu.yd. of excavation as measured in place in cut. In addition to the actual time during which the jobs were under observation and the quantities moved during this period, the average yardage and average number of dipper loads moved per hour have been computed. The percentage of the total time during which the shovel was actually at work moving material during the stop-watch studies is also shown, and from this basis the number of dipper loads which could have been moved per hour had the shovel been at work 100 per cent of the time has been computed. The average amount of material per dipper load has also been computed on the basis of the average yardage handled and the average number of dipper loads moved per hour.

It will be noted that while the ratio of the indicated capacities of the dippers for the two sizes of ¾-cu.yd. and 1-cu.yd. shovels is 1.33, the ratio of the average yardage moved per dipper load of the ¾-cu.yd. and ⅞-cu.yd. group to the 1-cu.yd. and 1⅛-cu.yd. group varies for the different materials from 1.40 to 1.60, the average being about 1.52. In other words, the group consisting of shovels having dippers with indicated capacities of 1 cu.yd. and 1⅛ cu.yd. moved about 50 per cent more material per dipper load than did the ¾-cu.yd. and ⅞-cu.yd. shovels. This figure also checks well with the several direct dipper-load determinations reported on page 255 of *Public Roads* for February, 1928, but which were based on much smaller total quantities and also on good rather than average operating conditions.

The most important indications shown in Table II, however, are that well-blasted rock can evidently be handled just as rapidly as ordinary common excavation, while poor blasting reduces the actual average rate of production by at least 12 cu.yd. per hour. The indications are also that on a job ordinarily operating with a high degree of efficiency the hourly reduction in yardage due to poor blasting is considerably larger, though the proportionate reduction is probably about the same.

These data should give the contractor a more substantial basis for figuring how much time and money he can afford to put into his drilling and blasting in order to insure that the material will be in proper shape for rapid handling by the shovel. They also indicate quite clearly the penalties he will probably pay if the blasting is poorly done. Under average conditions this reduction will apparently exceed 100 cu.yd. per day. Furthermore, under present customary methods of operation the full yardage could have been handled with little or no additional operating cost had it only been in proper condition. Thus if the bid price of moving solid rock be $1 per cubic yard, an increase of 100 cu.yd. per day in the rate of production would still be very profitable, even though it required an additional expenditure of $50 per day for more drilling and powder. In fact, these data show very clearly that under present keenly competitive prices, poor blasting is a luxury which the grading contractor can no longer afford.

Findings of an Industrial Reconnaissance of New England

Canvass of Manufacturing Conditions Shows That Industry Has Regional Problems—Favorable and Unfavorable Factors—Joint Study of Regional Problems of Industry Recommended

By Earl Whitehorne
Assistant Vice-President, McGraw-Hill Publishing Company, New York

A Few Weeks Ago a group of twenty editors of technical journals made a two-weeks tour of New England industries to observe recent and current industrial movements. Certain conclusions derived from this tour as to favorable and unfavorable factors, and a recommendation for regional study for more efficient development of industrial life, were presented by Mr. Whitehorne last week before the Fifth New England Conference at Boston. They bear directly on the value of regional study, and for this reason essential parts of the address are reproduced in abstract below. —Editor.

Favorable Factors

Extensive Diversification—Diversification is the outstanding fact of New England industry.

Excellent Labor Resources—New England has a traditional pride in its quality of product, and through its generations of development has reared a race of skilled industrial labor that forms a great reservoir of vital wealth.

Progressive Management—Many younger executives sense the growing importance of mechanization, of advanced personnel policies, of accurate market knowledge for the guidance of production and of the value of new ideas from other fields.

Much Special Machinery—The use of specialized equipment has reached a forward position.

Research Extending—Several cases of conspicuous progress in the application of research to the utilization of byproducts and the development of markets rate well with the best practice in the development of this important new resource of industry.

Human Relations Receiving Attention—Some examples can be found of the most advanced personnel work in the form of well-organized trade schools, shop councils, sanitary and hospital facilities and recreational provisions.

Growth—Despite the troubles of the textile industry, there is a net gain in number of industries and employees. This indicates a high capacity to absorb released labor.

Modernization Going On—Most New England industries are constructing their new buildings according to modern practice and applying the economic advantages of well-arranged machinery, good lighting, ventilation and sanitation, and the mechanical conveyance of materials.

Railways Excellent—Railway transportation receives almost universal commendation throughout the area. The reorganization of New England freight service that has been effected in recent years provides a resource for industrial development that is locally acknowledged and appreciated to a striking degree.

Power Well Developed—Electric power has kept pace with the growth of New England industries and, by the development of both hydro and steam generation, and the interconnection of systems, affords as progressive a service as is available in any section of the country and at favorable rates.

Unfavorable Factors

Much Obsolescence—New England industry is carrying a staggering burden of old buildings. Many date back more than 50 years and are not adapted to the efficient arrangement of modern machinery nor to present ideas of material handling. There is too much in and out and up and down. Too many are crowded into the center of congested districts where the value of land is high. It would pay better to erect new buildings on the fringe of town than to suffer longer the costs entailed by using ill-adapted structures.

Old Equipment—Many of the older industries are clinging to obsolete equipment because it has been written off and represents no book investment. They are denying themselves the practical economies of new equipment that is worth infinitely more. Forests of overhead belting, heavy friction loads, labor-wasting old machinery and ancient power plants are an inescapable drag on profits.

Bad Illumination—The lighting of New England factories appears to be distressingly bad, despite a few examples of the most advanced industrial illumination. Great floors of machinery spotted only with dirty lamps in inefficient or improvised reflectors at the tool, supported by no adequate general illumination, is a common condition. With this, dark halls and stairways come as a matter of course. It all takes an inevitable toll in accidents, slow speed and spoilage of materials.

Poor Housekeeping—As a natural attendant of poor lighting comes bad housekeeping—poorly arranged machinery, cluttered aisles, neglect of ventilation, painting, cleaning and modern sanitary facilities, and poor provision for the care of employees' clothing.

Neglect of Safety—Many alert plants are conducting safety competitions. Many apparently do no more than expose safety signs. There is a noticeable lack of the practical safeguards applied to machines, belts and tools that must be the backbone of all accident prevention work.

Deficiencies in Material Handling—The use of modern methods for material handling, while ingeniously developed in some plants, is in general in a backward state through lack of equipment and planning.

Imperfect Systematization—Opportunity also exists in the majority of the plants visited for the development of more continuous flow of work and progressive assembly by the use of conveyors and other devices.

High Inventories—There appears to be a tendency toward excessive inventory, in some lines of manufac-

ture, because of lack of more vision in production scheduling.

Undeveloped Human Relations—Because of the age of many of the industrial institutions and the traditions that have grown up both with the management and the workers, some of whom have followed their fathers into the plant, human relations are in places far behind the times. Working conditions, personnel policies and an inherited attitude of paternalism are apparently taken as a matter of course by both labor and management. This reflects itself in many ways—long hours of work, poor provision for the safety and comfort of workers, crude methods of hiring and firing and other sources of industrial unhappiness that write themselves plain in terms of bad morale and low return on the payroll.

Recommendations

New England is well organized. Every city has an active Chamber of Commerce; there are state industrial associations, and on top of these is the New England Council, pioneering in the new field of industrial coordination for this entire section. The New England Council is a piece of machinery that may be utilized effectively to many practical purposes. In a word, New England is more highly organized for industrial progress than any other section of the country. It is safe, therefore, to make these definite recommendations to New England industry:

1. That a census of industrial modernization be made throughout New England. To accomplish this a competent engineering staff could be retained to inspect a cross-section of, say, 1,000 manufacturing plants, and arbitrarily rate them for modernization of buildings, lighting, safety, material handling, flow of work, progressive assembly, research, human relations, and other characteristics. All reports to be confidential. Copies to be sent to the plants concerned. Mass figures to be analyzed and presented to all industries. Names of honor plants to be published.

2. That a centrally directed study be made through the state or local organizations of the effect upon industrial progress of economics of plant location; rates of pay, hours of operation and personnel policies; facilities for local transportation of workers; and local taxation and relations.

3. That systematic visiting of modern plants by New England industrialists be organized.

4. That the influence of transportation on New England industrial modernization be studied.

5. That the part played by electrification in the modernization of New England industries be studied.

6. That a balanced program of educational promotion be organized to inform and interest the people of New England in the story of New England's industrial progress and the reasons behind the recent economic movements; to advertise to the rest of American industry and business the economic strength of New England industries because of their diversification and their resources and tradition; to counsel local organizations in the most effective technique of presenting the picture of the natural, industrial, business, professional and civic resources of their communities to visiting groups.

Large 1930 Construction Volume Forecast

(*Continued from Page 840*)

fully scrutinize applications for loans, in order to protect existing investments. This and the large demand for insurance policy loans may prevent any large volume of mortgage money being available immediately.

Public bond-issue financing has been slightly checked by the low bond market during the last two years. Bond sales in the first ten months for both 1928 and 1929 totaled 13 per cent less in value than in the same period of 1927. In numerous instances bids were too low for favorable consideration or there were no bids at all.

At present the municipal bond market is on the upturn. The average yield, which had risen from 3.87 in January, 1928, to 4.49 in September, 1929, was 4.30 on Nov. 20. A still lower yield is predicted, even as low as 4, which formerly was regarded as normal, and this possibly in the course of a few months. But investment houses urge moderation so that absorption may be orderly.

What the Banks Say

We are making loans today on real estate where the security is satisfactory in the same manner as we have been and see no reason why meritorious real estate projects conservatively financed should not find a ready market now as they always have.—*A St. Louis Bank.*

The building and construction industry appears to be facing a period of further gradual reduction in activity. In spite of lower interest rates, it seems probable that building and construction will reflect the slackening in several basic lines of industry which was apparent before the sharp break in security prices, and which has had some slight stimulus since that event.—*A New York Bank.*

We have no doubt that savings deposits will now increase and that funds for mortgages will again be available in savings institutions in reasonable volume after the first of the year. It will take some months before substantial sums accumulate for mortgage investment, but the movement as we now see it is in a favorable direction.—*A New York Bank.*

Whereas there will probably be more mortgage money available in the immediate future, it is doubtful if conservative lenders will loan with any great freedom until they are certain that the demand for space balances with the available supply.—*A New York Surety Company.*

Expect our real estate loan operations to be close to normal in volume next year compared with current and average years' operations, due to insurance connections.—*A Kansas City Bank.*

We look forward to 1930 being at least an average year in construction operations with money easier for that purpose.—*A Minneapolis Bank.*

Construction here this year has been maintained substantially on a par with that of 1928. All indications point to increased activities during December. The present ample supply of money at reasonable rates is an invitation to those who have building projects in contemplation to proceed with their plans during the coming year.—*A San Francisco Bank.*

The Situation in Municipal Bonds

The law of supply and demand has a much greater influence on the price of municipals than is generally understood and in some periods has more to do with it than the cost of money.

Where the cost to municipalities issuing securities during the past two years has probably averaged 5½ to 6 per cent, we believe that this cost will be reduced, on the average, fully 1 per cent.

Bond inventory at the present is low. The amount of new securities is about normal, and from indications in the past few days it is expected a broad market will develop in the near future for municipal and other high-grade bonds.

For the 30-day period Nov. 15-Dec. 15, municipalities have advertised for bids on $70,000,000 bonds, a slight increase over the immediately preceding period. If the market continues good, however, projects which have been held in abeyance because of unsatisfactory prices will be brought forward again.

In more normal markets that have prevailed in the past few years the higher grade of municipal bond has yielded very little more than 4 per cent, the second grade approximately 4½ per cent, and the lowest grade in the neighborhood of 5 per cent. It is our opinion that these prices will again be reached within a very few months unless some entirely unforeseen factor enters the situation.

News of the Week

North Atlantic Coast Shaken by Earthquake

Heavy earth tremors were felt along the north Atlantic coast from New York to Newfoundland for an hour during the afternoon of Nov. 18, reaching their maximum in Nova Scotia. Resulting damage was, for the most part, confined to chimneys. A tidal wave, however, swept the southwest coast of Newfoundland over a 100-mile area, carrying away dwelling houses and other buildings and causing a loss of more than twenty lives. Unusually high tides were experienced elsewhere throughout the affected area, but without serious effect.

It is believed that the center of the disturbance occurred under the Atlantic Ocean, in what is known as the Fundian fault. Officials of the Dominion Observatory at Ottawa, Canada, placed the epicenter, at approximately longitude 58 deg. west, and latitude 46 to 48 deg. north. No earthquake of comparable magnitude has ever been registered in this immediate region, so far as the records at the observatory show.

Vehicular Tunnel Proposed Under Tampa Bay, Fla.

Application for permission to construct a 4,155-ft. vehicular tunnel under the main ship channel of Tampa Bay, Florida, at an estimated cost of $6,500,000 is now under consideration by the War Department. The tunnel, together with causeway and concrete trestle approaches, would aggregate 7 miles in length and would connect the lower tip of Pinellas County in the city of St. Petersburg with the extreme northern edge of Manatee County. It would form a link connecting the Gulf Coast highway and the Tamiami Trail, with a saving in distance of 42 miles over the present route through Tampa. The tunnel would be constructed of reinforced concrete, similar in design to the Alameda and Detroit vehicular tunnels. Potential traffic is estimated at 550,000 vehicles per year. The application was made by the West Coast Bridge & Tunnel Company, St. Petersburg.

Marine Terminal Projected in Jersey City

An agreement between the Port of New York Authority and the City Commission of Jersey City, N. J., provides for the development of the Little Basin and adjacent city-owned property fronting on the Hudson River which involves the construction of four piers, ranging in length from 1,000 to 1,200 ft. for passenger vessels, a marine basin for freight steamers and harbor craft, a marginal highway along the waterfront connecting with the Holland tunnel and railway connections with each of the five trunk railroads entering the city. Little Basin is the old terminal of the Morris Canal, abandoned several years ago. It is now the property of the State of New Jersey, from which it will be acquired by the Port Authority. The project is to be financed by bonds to be issued by the Port Authority to cover the entire cost of construction. When completed, the city will lease the terminal at an annual rental sufficient to pay the interest and amortization charges and will, in turn, sublet it for operation. Ownership will revert to Jersey City after the bonds have been amortized.

Hoover Calls for Co-operation From Industry

Business Leaders Gather at Washington in Response to President's Call—Construction Program Announced

By Paul Wooton
Washington Correspondent, Engineering News-Record

IN A SERIES of White House conferences called by President Hoover during the past week railway executives, business leaders, spokesmen for agriculture and labor officials promised the President their fullest co-operation in preventing any tendency to slacken up in industrial and business as a result of the stock-market deflation. A truce between capital and labor was inaugurated by promises of industrial leaders to maintain wages and by assurances on the part of labor leaders that no further attempts to increase the wage scale would be started in the near future. The President's general strategy is to put all the groups mentioned on their mettle so that they will make sure that there is no surrendering to needless alarm. All those who have been closeted with him have made very definite promises. A month hence there will be a checking up to ascertain the degree of compliance with those promises.

That the President's policy is taking hold is evidenced by reports that cancellation of orders in numerous instances have been revoked and the manufacturers instructed to ship the goods in compliance with the original order. Credit is abundant and cheap. There is no price inflation or accumulation of inventories, with a very few exceptions.

It is no secret that the White House conferences were staged primarily for the effect they would have on business executives and members of the boards of directors of corporations. They control enough buying power to make or break the situation. Since many men in those positions were hard hit personally in the crash of stocks, the world seems upside down to them. If their personal misfortune were to be reflected in the policy of their companies, the result would be to sit back and be cautious. It is this feeling of alarm that the President hopes to check. If employment can be maintained and if there is no drastic reduction in procurement programs, the President evidently believes the curve of business can be kept at the same high stable level it has followed for eight years.

Railroad buying in 1929 has been in greater volume than at any time since 1923. If this rate can be maintained during this emergency period, it is certain that the railroad supply companies will not have to discharge any men. By the end of 1929 the railroads will have expended $800,000,000 for betterments. There is reason to believe that in response to the President's suggestion the aggregate of betterment programs for 1930, to be reported a month hence at the Chicago meeting of the American Railway Association, will be in the neighborhood of $1,000,000,000.

Construction Conference

In calling the construction conference, which was held Nov. 22, President Hoover was interested more in securing information from this group than he was in getting promises for the stimulation of the activities represented by those in attendance. In addition to the President and the Secretary of Commerce, those in attendance were: T. T. Flagler, president Associated General Contractors; Sam Hotchkiss, president National Association of Builders' Exchanges; Frank H. Smith, president Portland Cement Association; Harry H. Culver, president National Association of Real Estate Boards; Wilford Kurth, former president National Board of Fire Underwriters; Frederick J. Reimer, president American Road Builders' Association; Samuel Eckels, president Association of State Highway Officials; E. L. Carpenter, president National Lumber Manufacturers' Association; F. W. Reimers, president Southern Pine Association; Arthur W. Berresford, president American Engineering Council; W. M. Wood, president American Institute of Steel Construction; A. Trieschmann, president Home Modernizing Bureau; D. T. Riffle, president National Building Trades Employers' Association; A. M. Lewin, president Retail Lumber Dealers' Association; Darwin P. Kingsley, presi-

dent New York Life Insurance Company; Julius Barnes, chairman of the board United States Chamber of Commerce.

Highway Work Plentiful

In the discussion with the President, the opinion was expressed that road construction offers a promising field for the absorption of such unemployment as may exist in certain lines. It also is a field in which relatively small expenditures on the part of the federal government insure the appropriation of many times that amount by the state. At the present time, the states are spending ten times as much as is the federal government. It was brought out at the conference that large stocks of cement and other road-building material are available and the needs of an expanded program of highway construction can easily be met by the producers of road-building materials. The President has been asked by the American Association of State Highway Officials to include $50,000,000 in the budget now being completed for additional federal aid for highways. This would make it possible to carry the program forward at the rate of $125,000,000 annually.

Private Building Construction

The President revealed during the course of the conference that he has hope that the unified effort to prevent recession may obviate any damage to the business structure. While it was very apparent that chief reliance for early results would have to come from highway work, it was made clear that there is urgent need for building construction in many localities. The principal dearth is in small apartments and modestly priced independent houses, it was pointed out. The state of the building and loan associations and the lack of second-mortgage money had resulted in the underbuilding of these types of residential structures, the President was told.

A quick survey is being made to gather more definite information as to the situation in residential, apartment and office building and of the financial machinery that can be employed for the stimulation of new construction. It was stated that many banks that are not disposed to finance new construction are willing to lend money for the improvement and modernization of homes already owned and occupied.

Contractors, as a whole, are working less than half of the time, it was stated. Levee work on the Mississippi River, [This view is not supported by the survey of construction published in this issue.] Levee work on the Mississippi River, it was declared, could be carried forward at double the present rate were the money available. One of the suggestions made to the President was that federal aid be extended to county roads. By requiring that federal standards be followed, 50 per cent of the cost of such roads could be saved, it was estimated.

Following his practice of turning over to industry the working out of suggestions he makes, the President called early attention to the fact that business now is so well organized that concerted movement can be carried into the most remote branches of the nation's activities in a very short time. With that in view and for the purpose of gathering precise information as to just what has happened in all fields, a meeting of some 250 leaders, representing practically every important activity in the country, will be held in Washington Dec. 5. This meeting is under the auspices of the President's advisory committee, of which Secretary Lamont is chairman.

Government Building Planned

An increase of $175,000,000 in the government's building construction program will be urged upon Congress next month as part of President Hoover's program. Congress already has authorized the expenditure of a total of $347,200,000, of which $272,200,000 will be distributed throughout the 48 states and $75,000,000 in the District of Columbia. The national program has been placed on a ten-year basis, as the annual rate of expenditure now is limited to $25,000,000. The district program is on a five-year basis at an annual rate of $10,000,000. Although the total annual allotment for district and country is only $35,000,000, approximately $50,000,000 is available for construction during the present fiscal year ending June 30, 1930, and a like amount during the next fiscal year. Very little of the $35,000,000 alloted for the year ended last June was expended, as the plans were still largely on paper. Under ordinary circumstances there would be a let-down in activity after the cumulative funds are absorbed. Enlargement of the building program, however, would add $17,000,000 to $20,000,000 to the average annual allotment of $35,000,000.

South Carolina Estimates Flood Damage to Highways

The State Highway Department of South Carolina estimates that a total of about $215,000 will be required to repair the damage caused in the state by floods during the last week in September. The central division suffered most heavily, the largest item of loss being the approach to the Sand Bar Ferry bridge below Augusta, Ga., which will cost $70,000 to replace. Another serious item is the loss of the concrete bridge over the Little Saluda River, between Batesbury and Prosperity, estimated at $55,000. In the western division of the state, the principal losses were of temporary wooden bridges. There was also pavement erosion and injury to bridges.

Navy Vessel Requested to Help Avert Power Shortage

Unusually low water in the storage reservoirs of the municipal power systems of Tacoma and Seattle, Wash., has led the two cities to request the U. S. Navy to lend the electrically driven airplane carrier "Lexington" to help avert a power shortage. The "Lexington," which is lying in Puget Sound near Seattle, can generate 210,000 hp. Under the plan promised, the vessel would be anchored in Tacoma harbor and her power plant tied in with the local distribution system, which, in turn, can be interconnected with the Seattle system. Naval officials have announced no decision on the request, but have stated that it would be granted only in the case of a "grave emergency," as the "Lexington" is needed in projected maneuvers and the department does not southeastern division.

BUILDING NEW YORK'S ELEVATED HIGHWAY

Herbert Photo.

Placing structural steel for the express motor highway which will carry New York City vehicular traffic along the Hudson River from Canal St. to 72nd St., a distance of approximately 4 miles. The illustration shows work in progress on the first section, being built by James B. Stewart & Company. Contracts for the two other sections of the highway have not yet been awarded, pending a decision in respect to the 1,000-ft. piers, the construction of which may possibly cause minor changes in the location of the highway. As shown in the illustration, provision is made for two separate roadways 30 ft. wide. The design provides for future addition of a second deck when increase in traffic warrants.

wish to make a precedent which may lead to similar requests later.

A serious situation confronts both cities; although the normal rainfall for Seattle is approximately 34 in. per year, since the first of this year the deficiency has been 11 in., so that streams show the lowest flow on record at this time. Full hydro-electric capacity for western Washington is 329,500 kw. and steam capacity is 116,000 kw. Under present conditions the peaks carried by the hydro stations amount to 190,000 kw. and by steam to 114,000 kw. City officials of Tacoma have announced that rationing of power to customers within city limits will begin this week, and that all customers outside city limits will be cut off at once. It is reported that the present river flow has reduced the 54,500-kw. rate of capacity of the Skagit plant of the Seattle municipal system to 15,000 kw. and that the Cedar River plant, of 40,000-kw. capacity, has been so reduced that only by making use of small pondage can it carry a peak of 8,000 kw. Seattle still continues to supply its customers beyond the city limits, but the two cities have discontinued helping each other out by interchange of power.

New Haven Sewage Plant Job Goes to Local Contractors

The contract for building the East St. sewage-disposal plant at New Haven, Conn., was awarded Nov. 18 to C. W. Blakeslee & Sons, of New Haven, on a unit price bid totaling $488,809, based on using a combination of Link-Belt and Dorr equipment. Bids were called for on three proposals: (1) the Link-Belt system of mechanically cleaned bar screens, grit chamber cleaning mechanism and sludge-removal apparatus; (2) Dorr equipment for the same purpose; (3) combination of Link-Belt mechanically cleaned bar screens and Dorr grit chamber cleaning mechanism and sludge-removal apparatus. Considering all the proposals, the succcessful bidder was fourth from low, according to the engineers' tabulations, as three bids based on all Link-Belt equipment were lower, two being submitted by outside contractors, the lowest of all coming from A. Phelps & Son, Detroit, totaling $461,192.

Bids for the plant were first taken Sept. 30. At that time the Mayor's advisory board announced that bidding would be restricted to local contractors, though nothing to this effect was stated in the official call for bids. Upon opening the bids it was found that two outside firms had submitted proposals and one, the Merritt-Chapman & Scott Corporation, New York, was low, using either Link-Belt or Dorr equipment. The board rejected all bids, stating that since outside contractors had bid, it would be best for the city's interests to give all outsiders a chance to bid with the hope that lower prices would result, and calling for new bids Nov. 8. However, the contract as finally awarded totals $3,239 above the lowest bid submitted on the original proposal.

A summary of the lower bids on both proposals follows: Original proposals: Merritt-Chapman & Scott Corporation, Link-Belt system, $485,566, Dorr system, $512,016; C. W. Blakeslee & Sons, Link-Belt system, $555,179, Dorr system, $575,190. Final proposals: A. Phelps & Son, Detroit, Link-Belt system, $461,192, Dorr system, $498,242, combination, $496,341; C. W. Blakeslee & Sons, Link-Belt system, $468,419, Dorr system, $489,440, combination, $488,809 (awarded contract); Merritt-Chapman & Scott Corporation, Link-Belt system, $473,550, Dorr system, $498,850, combination, $497,150. Fuller & McClintock, New York and Philadelphia, are consulting engineers on the project.

The Business Outlook

A somewhat better spirit is returning to the business community. After having listened to enough gloomy gossip to last them for awhile, business men are beginning to notice the fact that industrial and trade activity is fair. The rate of recession has slowed up to what is not much more than normal for the season. In two months the general seasonal decline in industrial operations, building and railroad traffic should be over and the usual signs of spring revival should begin to appear.

Steel ingot production for the industry as a whole declined somewhat further for the week, from 73 to 71 per cent of capacity, as compared with 81 per cent a year ago. General building contract awards continued to decline, but not seriously below last year's level. Proposed work is on the increase. Heavy construction contracts declined for the week ended Nov. 21 to about $63,000,000, but were above the same week last year.
—The Business Week, Nov. 27.

Centralia Taxpayer Gets Injunction Against Power Project

The hydro-electric power project proposed for development on the Nisqually River by the city of Centralia, Wash., has struck another legal snag as a result of a temporary writ of prohibition issued by the Lewis County Court ordering the city to refrain from making effective a proposed ordinance declaring an emergency appropriation of $676,423 in the 1930 budget. The injunction suit in which the writ was issued had been filed by H. M. Jones, a taxpayer and an employee of the Eastern Railway & Lumber Company, which now sells lighting to the city.

The voters of Centralia twice have approved construction of the project.

Los Angeles to Have Building With Aircraft Landing

Contracts have been let for a twelve-story building at the corner of Jefferson and Main Sts., Los Angeles, Calif., construction to start June 1, 1930, in which the roof has been especially designed for aircraft landings. The building itself will be 980 ft. long and 152 ft. wide, with the greater length in the direction of the prevailing west winds. Projecting platforms around the roof will increase the available landing area to approximately 200x1,200 ft.

Designed as an industrial loft building, the structure will cost about $10,500,000 to complete. Special facilities have been incorporated in the design to care for airplane traffic and for air industries in the building. The entire top floor below the roof will be devoted to hangar facilities and depot accommodations for passengers and freight. Giant elevators will lift planes of transport size from the top floor hangar to the roof take-off runway. Landing and launching devices are planned as an added safeguard. The contract for construction of the building has been awarded to the George A. Fuller Company, of New York.

Sand Hogs Trapped When Union Gang Cuts Caisson Air Line

Three caisson workers were trapped in a 4-ft. caisson 65 ft. deep in the mud of the Hackensack meadows Nov. 23 when a gang of about 30 members of a rival local union attacked the air lock and severed the air line feeding a caisson on the west approach of the passenger line bridge being built by the Pennsylvania Railroad over the Hackensack River at Kearny, N. J. One of the three men in the lock resisted efforts of the gang to reach him until the two other sand hogs were able to scramble up the safety ladder just ahead of onrushing waters. Then the three of them broke out of the lock and attempted to fight their way through the crowd of attackers. The two who had made the long climb to the top of the shaft were too weak to offer much resistance and were very badly beaten. One suffered a fractured skull and is not expected to live; the other also suffered severe injuries. Only the fact that the caisson had reached hardpan and could sink no further saved the two men in the bottom from being smothered when the air was released. About 12 lb. of air was on the caisson at the time.

The contractors, Senior & Palmer, of New York, state that the men they are employing are union men, belonging to a local organized by caisson workers on the Philadelphia-Camden bridge several years ago. According to the contractors, when the caisson workers employed on the main river piers of another bridge being built at that point across the river and belonging to Local 67, of Jersey City, had finished their work they demanded they be put to work on the approach job in place of those already at

work. The contractors refused to comply with this demand, and the members of Local 67 began threatening the men at work. On Nov. 20 and again on Nov. 22 the men at work were attacked as they left the job.

The lock tender, hoistman and compressor runner tried to stave off the attack. After beating the sand hogs the gang attempted to wreck the compressor plant, but were held off by a gun in the hands of the compressor runner. By this time a squad of policemen had arrived, and the whole gang was arrested. Most of them were fined $25 each, but five, including the secretary of Local 67, were bound over to the grand jury. Later all five were released in the custody of the police.

The approach sub-structure consists of eight piers resting on 68 4-ft. corrugated iron caissons sunk to hardpan 65 ft. below the meadow level.

Brief News

CITY PLANNING in Jacksonville, Fla., is assured by a vote of the governing bodies to adopt the comprehensive plan prepared by George W. Simons, Jr., consulting municipal engineer, of Jacksonville.

TO REDUCE STREET NOISES to a minimum Director of Streets and Sewers Brooks, of St. Louis, Mo., has announced that he will insist that all air compressors, steam shovels and similar devices used in the city be equipped with noise silencers.

ACQUISITION BY CONDEMNATION of the property of the Long Island Water Company, which serves about 10,000 patrons in the Rockaway section of New York City, has been authorized by the Board of Estimate. The present value of the system is estimated at $2,000,000.

HOLLAND HAS ANNOUNCED a road, bridge and railway construction program calling for the expenditure of $120,000,000 and including new road construction totaling 2,000 km. Pavement will be of tar macadam, brick, asphalt and other forms. Many bridges are planned to replace existing ferries.

FAULTY ROAD CONSTRUCTION is alleged by Carteret County, North Carolina, in a suit for $870,000 damages filed against the Simmons Construction Company, of Charlotte, and three former county officials. It is charged that the defendant corporation constructed approximately 53 miles of defective concrete and asphalt highway in the county during the incumbency of the three officials.

CONSTRUCTION HAS STARTED on a hydro-electric plant near the Luxemburg frontier of Germany which will eventually develop 830,000 hp. at a cost, including machinery, of 120 million marks. The dam will be 300 m. long, 106 m. high, with a storage capacity of 800,000,000 cu.m. Power will be supplied to Luxemburg, France, Belgium, Holland and part of Germany. Completion is expected by the end of 1932.

WASHINGTON NOTES

BY PAUL WOOTON
Washington Correspondent

Government Construction as a Stabilizer — States Threaten Tie-Up of Boulder Dam Project

IN LINE with the President's program to insure the country's prosperity through a continuance of the present rate of industrial activities, Senate leaders are maneuvering for early action on the prosperity reserve bill. This measure, sponsored by Senator Jones, of Washington, contemplates the speeding up of governmental construction during periods when conditions approach the depression stage.

Most of the Senators who give particular attention to economic problems have expressed the belief that the measure contains much merit. It is of course recognized by these Senators that the total amount of work that the government can authorize would be only a drop in the bucket compared with the country's business as a whole. It is believed, however, that though a speeding up of federal activities may be only a gesture, it will have a beneficial psychological effect at times when there is a slowing down of industry.

Senator Brookhart, of Iowa, a member of the Progressive bloc, is inclined to go even further than administration Senators in using the government's work to smooth out between the peaks of prosperity. He has already introduced a bill appropriating $25,000,000 for the construction of superhighways by the federal government. These roads would connect Portland, Me., with Portland, Ore., and the north Atlantic states with the Pacific southwest. They would be particularly designed for through traffic and would avoid intermediate points as far as practicable.

Changes in Illinois Waterway

Conversion of two dams in the Illinois River between its mouth and Utica into structures of the movable type has been decided upon by the office of the Chief of Engineers as the best means of completing the work on the 9-ft. project in that section of the river. Two other plans were considered but were rejected.

One of the alternative proposals considered called for the removal of the dams entirely. This was advocated because the flow of the river augmented by the Chicago diversion is sufficient to provide the necessary depth except during prolonged dry spells. The other proposal contemplated lowering the upper sills of the locks so as to increase the depth to 9 ft. It is 7 ft. at present.

These two proposals were dropped in deference to the one accepted because it is believed that this one combines the merits of the two others. It is pointed out that by removing large sections of the dams and putting in movable dams, navigation can pass over the structures unimpeded during the greater part of the year when the flow is sufficient. At the same time the locks will be available during low-water periods or in case the diversion should be curtailed. Ultimately it is planned to construct new locks of a larger size on the other side of the dams. These locks will probably be of dimensions similar to those under construction in the state's section of the waterway, which will be 600 ft. long and 110 ft. wide. The government under the present project will improve the waterway only up as far as Utica. Expenditure on the project is limited to $13,500,000.

Colorado River Power

As construction of Boulder Canyon dam would be delayed indefinitely by litigation challenging constitutionality of the law, Secretary of the Interior Wilbur will reserve decision on the allocation of power from the dam until the middle of December in the hope that in the meantime the State of Arizona will compose its differences with California. The Colorado River Commission of Arizona charges that California is trying to complete contracts with the federal government in order to eliminate both water and power revenues from discussion prior to resuming negotiations for establishment of a compact between the two states. Arizona and Nevada also have announced their intention of carrying their fight for preference to the U. S. Supreme Court. Tentatively allotted 18 per cent of the power developed by the dam for use within its boundaries under Secretary Wilbur's proposed plan, Nevada insists that it is entitled to a full third and also claims the right to sell power outside the state if it sees fit.

Under Secretary Wilbur's tentative plan the division of power as between public and private interests is approximately 50-50, but at the hearing Nov. 12-13 spokesmen for the city of Los Angeles and the Metropolitan Water District declared that they could agree to the direct allocation of power to the Southern California Edison Company only if the city is designated as the sole agent in charge of the operation of the power plant. They urged also that the government should build the plant and install the machinery, claiming that a saving of $2,000,000 to $3,000,000 would be effected if the government built both the dam and the power plant, including installation of equipment. Increasing the height of the dam was recommended in the interest of economy, which, the city's representatives said, could not be obtained in a dam limited to 550 ft. The proposed board of control should be empowered to act in an advisory capacity only, according to the municipal authorities, and under their plan Southern California Edison would have only one representative, the city of Los Angeles and the Metropolitan Water District two each, and the federal government any number. If the private company is not satisfied with allocation of power without a hand in control of the plant, the city holds that it can use all of the power and is able to pay for it.

Counsel for the Southern California Edison and associated companies con-

tended that under the policy expressed in the federal water-power act and extended by Congress to the Boulder dam act municipalities should receive preference only if their plans are equally well adapted with those of competing applicants to utilize in the public interest the water resources of the region, which, in this instance, includes not only Los Angeles and the smaller cities of southern California but a large area which is served only by the private companies. It was declared that the proposals made on behalf of the city of Los Angeles and the Metropolitan Water District would discriminate against the rural communities. The Southern California Edison, Secretary Wilbur was informed, is ready to provide, install and operate the machinery and to distribute the power among the other agencies in such amounts and at such prices as are fixed by the government.

Personal Notes

Major-Gen. LYTLE BROWN, Chief of Engineers, has been appointed by Secretary Wilbur a member of the technical committee of the Federal Oil Conservation Board in the place of Gen. Edgar Jadwin, resigned.

HAWLEY S. SIMPSON, for the past 2½ years traffic engineer in the office of the county engineer of Essex County, N. J., has resigned and will take a position on Dec. 1 with the American Electric Railway Association.

A. J. MCCORKLE, of Hammond, La., formerly chief engineer with H. A. Mentz & Company, Inc., has resigned to enter the contracting business. He recently received the contract for the construction of water-works in the town of St. Joseph, La.

JAMES C. NIEMEYER has been appointed city architect of St. Paul, Minn., and will have charge of designing buildings included in the extensive city building program to be undertaken under the $15,719,000 bond issue.

E. L. MOREY, architect, formerly of Hartford and New Britain, Conn., has become associated with R. J. Coe under the firm name of Morey & Coe, architects and engineers, successors to Stevens & Coe, of Barre, Vt., for general architectural practice.

CHARLES GRUNSKY, gas and electric engineer of the California Railroad Commission, has resigned, effective Nov. 15, to accept a position as supervising engineer with the management and engineering company which will direct the activities of the Pacific Public Service Corporation.

R. K. TIFFANY, Washington State supervisor of hydraulics, has resigned and CHARLES R. BARTHOLET, who has been assisting supervisor since organization of the office under the new water code of 1917, has been named supervisor. Mr. Tiffany will be associated with Lars Langloe, formerly affiliated with the hydraulics office, in irrigation, commercial and other branches of hydraulic work. Mr. Tiffany was recently appointed by President Hoover a member of the federal commission on reclamation and development of public lands.

EUGENE REYBOLD, major, Corps of Engineers, has been designated as the representative of the United States on the Niagara Control Board, in place of Lieut.-Col. DeWitt C. Jones, whose place as district engineer at Buffalo, N. Y., is also taken by Major Reybold.

WALTER A. SPERRY, of Grand Rapids, Mich., formerly service director to the city, has been appointed chief engineer and executive secretary of the stream control commission at Lansing, Mich. Recently Mr. Sperry has acted as consulting chemist, coaching the water-works employees of the city of Saginaw through the period of putting into operation the new filtration plant which was dedicated on Armistice Day.

LUIS EYQUEM, chief construction engineer for the Chilean Reclamation Service, and MIGUEL MONTALVA, chief assistant to the director of public works for the Chilean government, recently made a trip of inspection to the Rodriguez dam being constructed near Tia Juana, Baja California, Mexico, and to the Imperial Irrigation District in southern California. Later they paid a visit to the Orland irrigation project in northern California, where they inspected the recently completed Stony Gorge dam, and then left for Denver, Colo.

Society Calendar

AMERICAN CONCRETE INSTITUTE, Detroit; annual convention, New Orleans, La., Feb. 11-13.

AMERICAN CONSTRUCTION COUNCIL, New York City; annual meeting, Chicago, Ill., Dec. 12-14.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington; annual convention, Atlantic City, N. J., Jan. 11-18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; annual meeting, New York City, Jan. 15-17.

AMERICAN WOOD PRESERVERS ASSOCIATION, Chicago; annual meeting, Seattle, Wash., Jan. 28-30.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington; annual convention, New Orleans, La., Jan. 20-22.

NATIONAL CRUSHED STONE ASSOCIATION, Washington; annual convention, Cincinnati, Ohio, Jan. 20-23.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION, Washington; annual meeting, Chicago, Ill., Dec. 4-6.

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington; annual meeting, Memphis, Tenn., Jan. 28-30.

ASSOCIATION OF WESTERN STATE ENGINEERS will meet Dec. 9-11 at Reno, Nev. George M. Bacon, Salt Lake City, Utah, is secretary.

ENGINEERS SOCIETY OF MILWAUKEE at its annual meeting elected as new president William E. Crawford, consulting engineer of the A. O. Smith Company. T. Chalkley Hatton is vice-president and Hugo W. Rohde secretary.

NATIONAL ASSOCIATION OF BUILDING TRADES EMPLOYERS at its recent meeting in Pittsburgh, Pa., accepted an invitation from the American Federation of Labor to meet with the latter's executive committee during the week of Jan. 20, 1930, at Tampa, Fla., to discuss labor disputes caused by the allocation of work in building construction to the separate trades.

NEW JERSEY PUBLIC HEALTH AND SANITARY ASSOCIATION will hold its annual meeting at Asbury Park, N. J., on Dec. 6 and 7. C. L. Woolley Glen Rock, N. Y., is executive secretary

NORTHWEST SECTION, Associated General Contractors, has elected officers for 1930 as follows: president, A. A. McCree, St. Paul; vice-presidents, Edward Bjorklund and D. A. Daly, of St. Paul and H. M. Haagenson, of Minneapolis; secretary, J. D. Marshall.

TEXAS SANITARIANS' SHORT SCHOOL will be held at Edinburg, Tex., Dec. 3-5. J. R. Mahone, Edinburg, is secretary.

Obituary

W. T. BUTLER, general contractor, of Seattle, Wash., died suddenly in his office on Nov. 5, at the age of 61 years. Mr. Butler had been engaged in contracting in Seattle for twenty years.

LUCIEN A. MACLEOD, district engineer of the Washington State Highway Department, died on Nov. 11, aged 49 years. He had been with the department about twenty years.

JAMES J. RYAN, retired contractor, of Philadelphia, died on Nov. 16 at the age of 81. Besides laying many branch lines for railroad companies, including the laying of the tracks into Philadelphia for the Baltimore & Ohio Railroad, he built the Reading terminal in Philadelphia.

ARTHUR H. DIMOCK, former city engineer of Seattle, Wash., died Nov. 14 at the age of 64. Mr. Dimock was born in Nova Scotia, May 17, 1865. He entered the Seattle engineer's office as draftsman in 1897, became assistant city engineer in 1900 and city engineer in 1911. He retired from the last-named office in 1924 and since then had been engaged in private practice as a consulting engineer in Seattle. Mr. Dimock was a member of the American Society of Civil Engineers.

GEORGE C. KREUTZER, director of reclamation economics for the U. S. Bureau of Reclamation, died Nov. 23 in Washington at the age of 45. Mr. Kreutzer had been associated with reclamation projects in both this country and in Australia, having served as an executive engineer and agricultural economist for the River and Water Supply Commission of the State of Victoria, Australia, from 1910 to 1915. He was a member of the American Society of Agricultural Engineers and the Washington Society of Engineers.

BENJAMIN M. HALL, supervising engineer of the U. S. Reclamation Service for New Mexico, Texas and Oklahoma from 1904 to 1907, died in Atlanta, Ga., on Nov. 20. He was 76 years old. While with the Reclamation Service Mr. Hall negotiated the Mexico-Rio Grande treaty at El Paso. He made the original plans for the Elephant Butte dam and the Rio Grande project and supervised the settlement of water rights disputes on the Rio Grande. He organized the Porto Rico Irrigation Service and was its chief engineer from 1908 to 1910. He was the senior member of B. M. Hall & Sons, of Atlanta, consulting civil, mining and hydraulic engineers.

Construction Equipment and Materials

Corrugated Sheathing Used in Adjustable Forms

In a new type of adjustable form construction for concrete work which has been applied on some building contracts, the sheathing consists of light metal sheets corrugated for stiffness and perforated for attachment to waling strips, hangers or other parts of the form framework. For walls, this framework is built up of vertical and horizontal members or waling pieces, each composed of either a pair of light steel channels having the flanges inward or

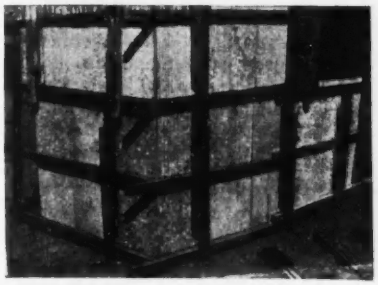


FIG. 1—WALL FORM ASSEMBLED

a pair of 2x4-in. timbers. Each member has spacing blocks at the ends and is provided with bolted clamps for length adjustment and for connecting at intersections. A section of form as erected is shown in Fig. 1, and typical sections of column forms are shown in Fig. 2. The corrugated metal sheathing, which is made specially for the purpose, is used not only for such flat surfaces as walls, floors, stairs and girders but also for floor arches and joists, circular and rectangular columns and special sections, the corrugated metal sheets being easily bent to the required shape. This patented type of form construction has been designed and used by the E. Blum Construction Company, Spokane, Wash., and is available for general use by purchase or rental.

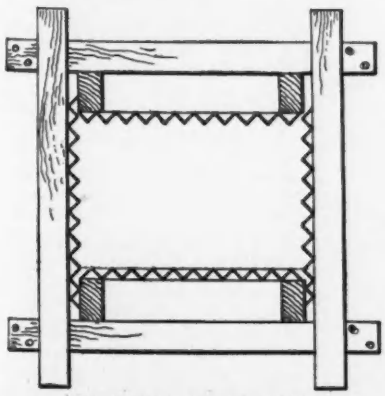


FIG. 2—TYPICAL COLUMN CONSTRUCTION

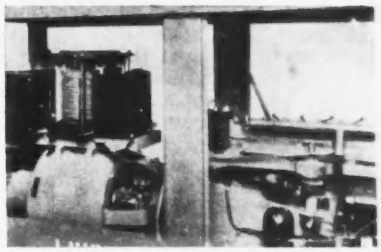
Above: Special column form with interlocking plates.

New Type of Welding Rod

A manganese-chrome-iron welding rod known as Hascrome has been developed by the Haynes Stellite Company, Kokomo, Ind., for the primary purpose of building up badly worn parts preparatory to surfacing them with Haynes Stellite, which is also supplied in the form of welding rod. Since the cost of Hascrome is materially less than Stellite, the resulting composite surface is much cheaper than it would be if entirely built up of the latter. Hascrome is sufficiently hard to resist deformation under impact and forms an excellent base for Stellite. Although it can be used alone for hard-surfacing on parts subject to abrasion, it does not possess hardness to the same degree as Stellite and will wear away more rapidly. The material has a Brinell hardness varying from 250 to 500, depending upon the rate of cooling and the amount of acetylene in the welding flame. It develops a tensile strength of 40,000 and a compressive strength of 177,000 lb. per sq.in. The material can be forged and ground but not machined. Hascrome can also be applied by means of the metallic arc process, developing a hardness of some 240 to 400 Brinell.

Idling Device Saves Fuel on Gasoline Welders

Fuel economy in the operation of gasoline-driven welders is secured by means of an automatic idling device or throttle control developed by the Lincoln Electric Company, Cleveland, Ohio, manufacturer of Stable-Arc welders. This mechanism automatically increases the speed of the engine from normal or idling speed to the proper speed for welding service whenever the arc is struck, and reduces it automatically when welding is discontinued. Operating mechanism consists principally of a small metal bellows and an electric magnet. When the arc is struck, the armature of the electric magnet opens a relief valve in the bellows, causing it to inflate. This, in turn, allows a coil spring to open the engine throttle. When welding operations cease, the bellows is deflated by the suction of the engine intake, thus causing the closing of the throttle. A control lever is provided by means of which the device may be set for automatic throttle control, for continuous idling or for governed speed.

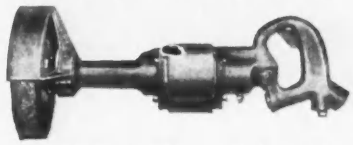


AUTOMATIC THROTTLE CONTROL MOUNTED ON GASOLINE WELDER

Provision is made in the design so that a momentary interruption in welding will not cause a reduction on speed of the engine.

Grinder Driven by Air Motor

As the first of a series of pneumatic tools employing the rotary principle, the Chicago Pneumatic Tool Company, New York City, has brought out a rotary grinder driven by the action of compressed air on four vanes rotating on a spindle in a casing. The machine is made in two types, with either straight or pistol group handles, and rotates at 4,250 revolutions per minute. It weighs approximately 15 lb., is

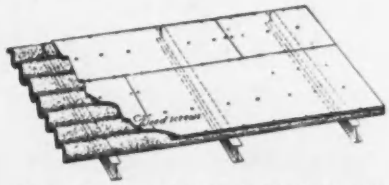


GRINDER WITH PISTOL GRIP

governor controlled, is non-vibrating, has an air strainer and is equipped with heavy-duty radial and thrust ball bearing on the wheel end. The rotor is mounted on ball bearings and is equipped with an automatic oiler. Grinding wheels may be had either 6 or 8 in. in diameter and are equipped with guards.

Asbestos Roof Section Laid Flat

Asbestos cement, well known as a roofing material in the form of shingles and corrugated slabs, can be used also on flat surfaces by means of a new roof design developed by R. A. Laidlaw, San Antonio, Tex. This is known as the Enduro roof and floor deck, and can also be used for floors. In either application the load is carried by a corrugated section of asbestos cement, which is covered by a flat sheet of the same material which provides a surface for the finishing treatment. The flat slab increases the strength of the deformed sheet and also forms a series of air



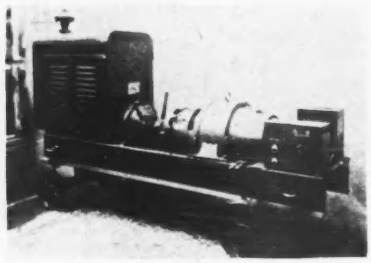
SECTION OF FLAT ASBESTOS ROOFING

pockets for insulation. End joints in the corrugated sheets occur at the supports, while in the flat sheets these are at the middle of the span, thus providing continuity over the supports. Side joints in the flat slabs come at the centers of the corrugated sections.

All joints are butt joints. Sheets are made 27½ in. wide and in lengths of from 4 to 10 ft. Standard and deep sections of the corrugated slab are available.

Dual-Drive Welder Driven by Electric or Gasoline Motor

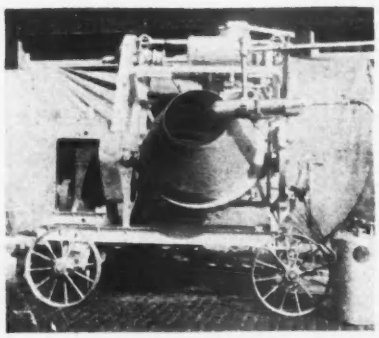
Structural steel contractors and others who must do welding work at different locations will find many advantages in the dual-drive welding machine introduced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This consists of a standard 300-amp., single-operator welding generator, a 15-hp. a.-c. induction motor and a six-cylinder, model P-45 Continental gasoline engine, all mounted in tandem on a welded structural steel base. Additional flexibility is provided by so wiring the electric motor that it can be used on either 220- or 440-volt circuits. The generator is driven by either the gasoline engine or the electric motor, a slip coupling or clutch being provided to disengage the unused unit.



DUAL-DRIVE WELDING UNIT

Heater Used With Tilting Mixers

Easy attachment to any make of tilting drum concrete mixer is a feature of a universal concrete heater attachment developed by Littleford Bros., Cincinnati, Ohio. This clamps on any angle or flat iron brace on the mixer by means of two set screws. The mounting is so arranged that there is no interference with the tilting of the drum. The complete outfit consists of a Littleford torch type oil burner, a flame deflector, a fuel tank and the universal attachment. The heating unit is mounted on a swivel so the operator can easily turn the mouth of the flame directly into the mixing drum. A special type of bracket is used for the small-sized burner for use with 3½-cu.ft. mixers. Larger sizes with universal brackets are used with mixers of from 5- to 14-cu.ft. capacity. Littleford heaters are also made for use with non-tilting mixers.



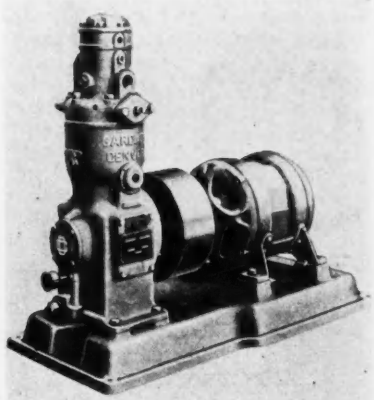
HEATER UNIT MOUNTING ON TILTING MIXER

REMOVING THE BUMPS FROM A CONCRETE ROAD

By mounting a standard Jackhamer drill on a special carriage, the Ingersoll-Rand Company, New York City, has produced a machine for removing high spots from concrete surfaces which is adaptable not only to highway work but to floors, shipping platform and other places where smoothness is essential. The machine can also be used to remove the film or scale that forms on top of a concrete base when preparing it for a finishing coat, and for channeling concrete floors.

Two-Stage Vertical Compressor

Low- and high-pressure cylinders and intercooler are combined in a single casting in the new two-stage air compressor of the vertical tandem type recently announced by the Gardner-Denver Company, Denver, Colo. The compressor, which weighs only 350 lb., will produce a continuous flow of 24 cu.ft. of air per minute at pressures up to 500 lb. Main bearings are of the Hyatt roller type. Lubrication is effected by a combination oil pump and splash system. The compressor can be furnished with pulley for V belt drive or for direct connection to an electric motor, steam or gas engine. It is particularly suited for oil and gas engine starting purposes and other services requiring small volumes of air at moderately high pressures.



TWO-STAGE VERTICAL COMPRESSOR WITH ELECTRIC DRIVE

Costs and Contracts

E. N.-R. Index Numbers

Cost			Volume		
Nov. 1,	**1929**	**208.46**	**Oct.,**	**1929**	**273**
Oct. 1,	1929	206.32	September,	1929	340
Nov. 1,	1928	209.46	October,	1928	363
Average,	1928	206.78	Average,	1928	287
Average,	1927	206.24	Average,	1927	263
1913.....		100.00	1913.....		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of Nov. 28, with some comparisons, total as follows:

(In Thousands of Dollars)

	Nov. 28, 1929	Nov. 21, 1929	Nov. 29 1928
Buildings:			
Industrial.....	$15,203	$5,866	$21,599
Commercial....	10,417	42,410	22,181
Streets and roads.	2,720	8,065	1,599
Other eng. constr.	5,631	6,849	29,088
Total.....	$33,971	$63,190	$74,467
Total, all classes, Jan. 1 to Nov. 28:			
1929.....			$3,792,201
1928.....			3,341,488